F 5

```
   SSSSSSSSSSSS  DDDDDDDDDDDD        AAAAAAAAA
   SSSSSSSSSSSS  DDDDDDDDDDDD        AAAAAAAAA
   SSSSSSSSSSSS  DDDDDDDDDDDD        AAAAAAAAA
SSS              DDD         DDD  AAA         AAA
SSS              DDD         DDD  AAA         AAA
SSS              DDD         DDD  AAA         AAA
SSS              DDD         DDD  AAA         AAA
SSS              DDD         DDD  AAA         AAA
SSS              DDD         DDD  AAA         AAA
   SSSSSSSSS     DDD         DDD  AAA         AAA
   SSSSSSSSS     DDD         DDD  AAA         AAA
   SSSSSSSSS     DDD         DDD  AAA         AAA
            SSS  DDD         DDD  AAAAAAAAAAAAAAA
            SSS  DDD         DDD  AAAAAAAAAAAAAAA
            SSS  DDD         DDD  AAAAAAAAAAAAAAA
            SSS  DDD         DDD  AAA         AAA
            SSS  DDD         DDD  AAA         AAA
            SSS  DDD         DDD  AAA         AAA
SSSSSSSSSSSS     DDDDDDDDDDDD     AAA         AAA
SSSSSSSSSSSS     DDDDDDDDDDDD     AAA         AAA
SSSSSSSSSSSS     DDDDDDDDDDDD     AAA         AAA
```

```
_S

Sy
--
CT
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```

FILEID**DECODE   L 7

```
DDDDDDDD    EEEEEEEEEE    CCCCCCCC    OOOOOO    DDDDDDDD    EEEEEEEEEE
DDDDDDDD    EEEEEEEEEE    CCCCCCCC    OOOOOO    DDDDDDDD    EEEEEEEEEE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EEEEEEEE    CC           OO     OO  DD       DD EEEEEEEE
DD       DD EEEEEEEE    CC           OO     OO  DD       DD EEEEEEEE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EE          CC           OO     OO  DD       DD EE
DD       DD EE          CC           OO     OO  DD       DD EE              ....
DD       DD EE          CC           OO     OO  DD       DD EE              ....
DDDDDDDD    EEEEEEEEEE    CCCCCCCC    OOOOOO    DDDDDDDD    EEEEEEEEEE      ....
DDDDDDDD    EEEEEEEEEE    CCCCCCCC    OOOOOO    DDDDDDDD    EEEEEEEEEE      ....

LL            IIIIII      SSSSSSSS
LL            IIIIII      SSSSSSSS
LL              II      SS
LL              II      SS
LL              II      SS
LL              II      SS
LL              II        SSSSSS
LL              II        SSSSSS
LL              II              SS
LL              II              SS
LL              II              SS
LL              II              SS
LLLLLLLLLL    IIIIII    SSSSSSSS
LLLLLLLLLL    IIIIII    SSSSSSSS
```

LIB
V04

```
0 %TITLE 'Instruction decoder'
0 MODULE lib$ins_decode (IDENT = 'V04-000',
0         ADDRESSING_MODE (EXTERNAL = LONG_RELATIVE)) =
1 BEGIN
1
1 !++
1 !
1 !****************************************************************************
1 !*                                                                          *
1 !*  COPYRIGHT (c) 1978, 1980, 1982, 1984 BY                                 *
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1 !*                                                                          *
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1 !*  SOFTWARE ON EQUIPMENT WHICH IS NOT SUPPLIED BY DIGITAL.                 *
1 !*                                                                          *
1 !*                                                                          *
1 !****************************************************************************
1
1 ! FACILITY:
1 !       VAX instruction decoder.
1 !
1 ! Portions taken from DBGINS module by KEVIN PAMMETT, 2-MAR-77
1 !
1 ! Author:       Tim Halvorsen, 09-Feb-1981
1 !
1 ! Modified by:
1 !
1 !       V002    TMH0002         Tim Halvorsen   09-Aug-1981
1 !               Remove SHR psect attribute so linker doesn't generate a
1 !               non-crf writable section, and the imgact doesn't try to map
1 !               a read/write shared section to the .EXE file.
1 !
1 !       V001    TMH0001         Tim Halvorsen   09-Mar-1981
1 !               Use PLIT psect rather than OWN psect for read-only
1 !               data arrays.  Make each failure status a separate
1 !               code to aid in debugging the case of a decode failure.
1 !               Remove probes of instruction stream because a PROBER
1 !               instruction determines the access from the previous
1 !               mode, not the current mode.  Thus, if you call this
1 !               routine with a stream readable only to the current mode,
1 !               it will fail.  For now, we skip the checks and allow
1 !               an access violation to occur within the routine.
1 !--
1
1 !
```

```
;    58          0058  1 ! Require and Library files:
;    59          0059  1 !
;    60          0060  1
;    61          0061  1 LIBRARY 'SYS$LIBRARY:STARLET';             ! Standard VMS definitions
;    62          0062  1 SWITCHES LIST(REQUIRE);
;    63          0063  1 REQUIRE 'SRC$:VAXOPS';                     ! Literals and macros related to opcodes
;  R0064   1        ! VAXOPS.REQ - OP CODE TABLE FOR VAX INSTRUCTIONS
;  R0065   1        !
;  R0066   1        ! Version:       'V04-000'
;  R0067   1        !
;  R0068   1        !****************************************************************************
;  R0069   1        !*                                                                          *
;  R0070   1        !*  COPYRIGHT (c) 1978, 1980, 1982, 1984 BY                                 *
;  R0071   1        !*  DIGITAL EQUIPMENT CORPORATION, MAYNARD, MASSACHUSETTS.                  *
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;  R0079   1        !*  TRANSFERRED.                                                            *
;  R0080   1        !*                                                                          *
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;  R0084   1        !*                                                                          *
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;  R0086   1        !*  SOFTWARE ON EQUIPMENT WHICH IS NOT SUPPLIED BY DIGITAL.                 *
;  R0087   1        !*                                                                          *
;  R0088   1        !*                                                                          *
;  R0089   1        !****************************************************************************
;  R0090   1        !
;  R0091   1        !  Author:
;  R0092   1        !               KEVIN PAMMETT, MARCH 2, 1977.
;  R0093   1        !
;  R0094   1        ! Modified by:
;  R0095   1        !
;  R0096   1        !       V001    TMH0001         Tim Halvorsen   09-Feb-1981
;  R0097   1        !               Rewrite macro invocations to supply the entire SRM
;  R0098   1        !               operand specification, to allow checking for literals
;  R0099   1        !               in write operands, and other invalid conditions.
;  R0100   1        !--
;  R0101   1
;  R0102   1       LITERAL
;  R0103   1
;  R0104   1        !
;  R0105   1        ! OPERAND ACCESS TYPE (A,B,M,R,V,W) - 1 BIT WIDE
;  R0106   1        !
;  R0107   1
;  R0108   1               ACCESS_A = 0,                   ! EFFECTIVE ADDRESS
;  R0109   1               ACCESS_B = 0,                   ! BRANCH DISPLACEMENT
;  R0110   1               ACCESS_R = 1,                   ! OPERAND IS READ-ONLY
;  R0111   1               ACCESS_W = 0,                   ! OPERAND IS WRITE-ONLY
;  R0112   1               ACCESS_M = 0,                   ! OPERAND IS MODIFIED
;  R0113   1               ACCESS_V = 0,                   ! ADDRESS A SET OF 2 REGISTERS
;  R0114   1
;  R0115   1        !
;  R0116   1        ! OPERAND DATA TYPE (B,W,L,Q,F,D,G,H,V) - 3 BITS WIDE
;  R0117   1        !
;  R0118   1
;  R0119   1               DATA_B = 0,                     ! BYTE CONTEXT
;  R0120   1               DATA_W = 1,                     ! WORD CONTEXT
;   R0121   1               DATA_L = 2,                         ! LONGWORD CONTEXT
;   R0122   1               DATA_Q = 3,                         ! QUADWORD CONTEXT
;   R0123   1               DATA_F = DATA_L,                    ! FLOATING CONTEXT
;   R0124   1               DATA_D = DATA_Q,                    ! FLOATING DOUBLE CONTEXT (8 BYTES)
;   R0125   1               DATA_G = DATA_Q,                    ! FLOATING GRAND CONTEXT (8 BYTES)
;   R0126   1               DATA_H = 4,                         ! FLOATING HUGE CONTEXT (16 BYTES)
;   R0127   1
;   R0128   1       !
;   R0129   1       ! BRANCH DISPLACEMENT TYPES
;   R0130   1       !
;   R0131   1
;   R0132   1               NO_BRANCH = 0,                      ! NO BRANCH
;   R0133   1               BRANCH_BYTE = 1,                    ! BRANCH BYTE
;   R0134   1               BRANCH_WORD = 2;                    ! BRANCH WORD
;   R0135   1
;   R0136   1       !
;   R0137   1       ! THE FOLLOWING MACRO IS USED TO BUILD SUCCESSIVE ENTRIES FOR
;   R0138   1       ! THE TABLE.  EACH MACRO CALL CONTAINS THE
;   R0139   1       ! INFO FOR 1 VAX OPCODE, AND THE ENTRIES ARE SIMPLY
;   R0140   1       ! BUILT IN THE ORDER THAT THE MACRO CALLS ARE MADE -
;   R0141   1       ! THE ASSUMPTION IS THAT THEY WILL BE MADE IN ORDER OF
;   R0142   1       ! INCREASING OPCODE VALUES.  THIS IS NECESSARY BECAUSE
;   R0143   1       ! THE TABLE IS ACCESSED BY USING A GIVEN OPCODE AS THE
;   R0144   1       ! TABLE INDEX.
;   R0145   1       !
;   R0146   1
;   R0147   1       COMPILETIME $BRANCH_TYPE=0;
;   R0148   1
;   R0149   1       MACRO
;   R0150   1           GET_1ST(A,B) = A%,
;   R0151   1           GET_2ND(A,B) = B%,
;  MR0152   1           OPERAND(NAME) =
;  MR0153   1               %IF %NULL(NAME)
;  MR0154   1               %THEN
;  MR0155   1                   0
;  MR0156   1               %ELSE
;  MR0157   1                   BEGIN
;  MR0158   1       !           %IF NOT %DECLARED(%STRING('ACCESS_',GET_1ST(%EXPLODE(NAME))))
;  MR0159   1       !           %THEN
;  MR0160   1       !               %WARN('Invalid access type ',GET_1ST(%EXPLODE(NAME)))
;  MR0161   1       !           %FI
;  MR0162   1       !           %IF NOT %DECLARED(%STRING('DATA_',GET_2ND(%EXPLODE(NAME))))
;  MR0163   1       !           %THEN
;  MR0164   1       !               %WARN('Invalid data type ',GET_2ND(%EXPLODE(NAME)))
;  MR0165   1       !           %FI
;  MR0166   1                   %IF NAME EQL 'BB'
;  MR0167   1                   %THEN
;  MR0168   1                       %ASSIGN($BRANCH_TYPE, BRANCH_BYTE)
;  MR0169   1                   %ELSE %IF NAME EQL 'BW'
;  MR0170   1                   %THEN
;  MR0171   1                       %ASSIGN($BRANCH_TYPE, BRANCH_WORD)
;  MR0172   1                   %FI %FI
;  MR0173   1                   %NAME('DATA_',GET_2ND(%EXPLODE(NAME))) +
;  MR0174   1                       %NAME('ACCESS_',GET_1ST(%EXPLODE(NAME))) ^ 3
;  MR0175   1                   END
;   R0176   1               %FI %,
;   R0177   1
```

```
        OPDEF(NAME, OPC, OP1, OP2, OP3, OP4, OP5, OP6) =
            %ASSIGN($BRANCH_TYPE,NO_BRANCH)
            %RAD50_11 NAME,                         ! Opcode name in RAD50
            %IF GET_1ST(%EXPLODE(NAME)) EQL 'X'     ! If undefined opcode,
                AND GET_2ND(%EXPLODE(NAME)) EQL 'X'
            %THEN
                NOT_AN_OP                           ! then no operands
            %ELSE
                %LENGTH-2                           ! else, number of operands
            %FI OR
                OPERAND(OP1)^4,                     ! Define each operand
            OPERAND(OP2) OR
                OPERAND(OP3)^4,
            OPERAND(OP4) OR
                OPERAND(OP5)^4,
            OPERAND(OP6) OR
                $BRANCH_TYPE^4%;                    ! Define branch context

    !
    ! MACROS TO ACCESS THE FIELDS.
    !

    MACRO
        OP_NAME      = 0,0,32,0%,              ! OPCODE MNEUMONIC (6 RAD50 CHARS)
        OP_NUMOPS    = 4,0,4,0%,               ! NUMBER OF OPERANDS
        OP_CONTEXT(I) = 4+I/2, ((I) AND 1)*4, 3, 0 %, ! OPERAND CONTEXT
        OP_DATATYPE(I) = 4+I/2, ((I) AND 1)*4 + 3, 1, 0 %, ! OPERAND DATA TYPE
        OP_BR_TYPE = 7,4,4,0 %;                ! CONTEXT OF BRANCH DISPLACEMENT

    LITERAL
            OPTSIZE = 8,            ! EACH OPINFO BLOCK IS 9 BYTES LONG.
            MAXOPCODE = %X'FD',     ! MAXIMUM VAX OP CODE WHICH IS VALID.
            MAXOPRNDS = 6,          ! MAXIMUM NUMBER OF OPERANDS PER INSTRUCTION.
                                    ! NO INSTRUCTION THAT HAS BRANCH TYPE ADDRESSING
                                    ! CAN HAVE THIS MANY OPERANDS UNLESS WE CHANGE
                                    ! THE ORGANIZATION OF EACH OPINFO BLOCK.
            BITS_PER_BYTE = 8,      ! NUMBER OF BITS IN A VAX BYTE.
            AP_REG  = 12,           ! NUMBER OF PROCESSOR REGISTER, 'AP'.
            PC_REG  = 15,           ! NUMBER OF PROCESSOR REGISTER, 'PC'.

            PC_REL_MODE = 8,        ! ADDRESSING MODE: (PC)+
            AT_PC_REL_MODE = 9,     ! ADDRESSING MODE: @(PC)+
            INDEXING_MODE = 4,      ! ADDRESSING MODE: XXX[RX]

            SHORT_LIT_AMODE = 0,    ! Short literals fit right into the mode byte.
            REGISTER_AMODE  = 5,    ! Register mode addressing.
            REG_DEF_AMODE   = 6,    ! Register deferred addressing mode.
            AUTO_DEC_AMODE  = 7,    ! Auto decrement addressing mode.
            AUTO_INC_AMODE  = 8,    ! Auto Increment addressing mode.
            DISP_BYTE_AMODE = 10,   ! All of the displacement modes start from
                                    !  here.  See ENC_OPERAND() IN DBGENC.B32
            DISP_LONG_AMODE = 14,
            OP_CH_SIZE = 6;         ! SIZE, IN ASCII CHARS, OF OPCODE MNEMONIC.

    MACRO
            DSPL_MODE = 0,4,4,0 %,  ! ADDRESSING MODE BITS FROM THE DOMINANT MODE
                                    !  BYTE OF AN OPERAND REFERENCE.
        DOM_MOD_FIELD = 0,5,2,1 %,
                                 ! BITS WHICH WE PICK UP TO DIFFERENTIATE CERTAIN
                                 !  TYPES OF DOMINANT MODES.  SEE DBGMAC.B32
        SHORT_LITERAL = 0,0,6,0 %,
                                 ! HOW TO EXCTRACT A 'SHORT LITERAL' FROM
                                 !   THE INSTRUCTION STREAM.  SEE SRM.
        AMODE   = 0,4,4,1 %,     ! BITS OF DOMINANT MODE ADDRESSING BYTE
                                 !   WHICH SPECIFY THE ACTUAL MODE.
        AREG    = 0,0,4,0 %,     ! BITS OF DOMINANT MODE ADDRESSING BYTE
                                 !   WHICH SPECIFY REGISTER NUMBER, ETC.
        NOT_AN_OP = 15 %,        ! OP NUMOPS INDICATOR FOR UNASSIGNED OPCODES.
        RESERVED = 'UNUSED' %;   ! NAME OF RESERVED OPCODES.


MACRO
        NEXT_FIELD(INDEX)        ! USED TO GET THE ADDRESS OF THE NEXT
                                 !   FIELD OF A BLOCK.
                = (INDEX),0,0,0 %;

!  MACROS AND LITERALS SPECIFICALLY FOR INSTRUCTON ENCODING.
!  ('MACHINE -IN'.)

LITERAL
        BAD_OPCODE      = 1,     ! CAN'T INTERPRET THE GIVEN ASCII OPCODE.
        BAD_OPERAND     = 2,     ! UNDECODABLE OPERAND REFERENCE.
        BAD_OPRNDS      = 3,     ! WRONG NUMBER OF OPERANDS.
        INS_RESERVED    = 4;     ! GIVEN OPCODE IS RESERVED.

LITERAL
                ! We only have to special-case a few OPCODES,


        OP_CASEB        = %X'8F',
        OP_CASEW        = %X'AF',
        OP_CASEL        = %X'CF';
!++
!
!       TOKEN VALUES USED FOR ENCODING/DECODING
!
!--

LITERAL
        indexing_token  = 240,
        val_token       = 241,
        byte_val_token  = val_token + %SIZE(VECTOR[1,BYTE]),      ! 242
        word_val_token  = val_token + %SIZE(VECTOR[1,WORD]),      ! 243
        brch_token      = 244,
        long_val_token  = val_token + %SIZE(VECTOR[1,LONG]),      ! 245
        at_reg_token    = 246,
        register_token  = 247,
        lit_token       = 248,
        bad_token       = 249;


! The following structure declaration selects the proper opcode
! table by looking for the extended opcode opcode(s).

```

```
:   R0292  1        STRUCTURE OPCODE_TBL [OPC,O,P,S,E] =
:   R0293  2                BEGIN
:   R0294  2                EXTERNAL LIB$GB_OPINFO1 : BLOCKVECTOR[256,OPTSIZE,BYTE];
:   R0295  2                EXTERNAL LIB$GB_OPINFO2 : BLOCKVECTOR[256,OPTSIZE,BYTE];
:   R0296  2                LOCAL OFFSET;
:   R0297  2                OFFSET = O;
:   R0298  2                IF (OPC AND %X'FF') NEQ %X'FD'
:   R0299  2                THEN LIB$GB_OPINFO1[OPC,.OFFSET,0,8,0]  ! One byte opcodes
:   R0300  2                ELSE LIB$GB_OPINFO2[(OPC^-8),.OFFSET,0,8,0]     ! Two byte opcodes
:   R0301  1                END<P,S,E>;
:   R0302  1
:   R0303  1        !       VAXOPS.REQ      - last line
```

```
;     65          0304  1 %SBTTL 'Module declarations'
;     66          0305  1
;     67          0306  1 !
;     68          0307  1 ! Table of contents:
;     69          0308  1 !
;     70          0309  1
;     71          0310  1 LINKAGE
;     72          0311  1     ptr_linkage = CALL: GLOBAL(stream_ptr=11),
;     73          0312  1     append_linkage = JSB(REGISTER=0,REGISTER=1);
;     74          0313  1
;     75          0314  1 FORWARD ROUTINE
;     76          0315  1     lib$ins_decode,                          ! decode an instruction.
;     77          0316  1     ins_operand:        ptr_linkage,         ! print out an operand reference.
;     78          0317  1     branch_type:        ptr_linkage,         ! handle branch type addressing.
;     79          0318  1     displacement:       ptr_linkage,         ! extract displacement from instruction
;     80          0319  1     ins_context,                             ! get expected context of an operand
;     81          0320  1     put_reg:            NOVALUE,             ! print a register reference.
;     82          0321  1     append_address:     NOVALUE,             ! Append an address
;     83          0322  1     append_hex:         NOVALUE,             ! Append a hex value
;     84          0323  1     append_decimal:     NOVALUE,             ! Append an unsigned decimal value
;     85          0324  1     append_rad50:       NOVALUE,             ! Append a RAD50 string
;     86          0325  1     append_string:      append_linkage NOVALUE; ! Append string to the output buffer
;     87          0326  1
;     88          0327  1 !
;     89          0328  1 ! Psect declarations
;     90          0329  1 !
;     91          0330  1
;     92          0331  1 PSECT
;     93          0332  1     OWN  = z$debug_code(PIC,WRITE,EXECUTE,ALIGN(2)),
;     94          0333  1     CODE = z$debug_code(PIC,WRITE,EXECUTE,ALIGN(2)),
;     95          0334  1     PLIT = z$debug_code(PIC,WRITE,EXECUTE,ALIGN(2));
;     96          0335  1
;     97          0336  1 !
;     98          0337  1 ! Equated symbols:
;     99          0338  1 !
;    100          0339  1
;    101          0340  1 LITERAL
;    102          0341  1     true = 1,
;    103          0342  1     false = 0,
;    104          0343  1     round_brackets      = 0,                 ! These are all flag parameters to
;    105          0344  1     square_brackets     = 2,                 !    the routine 'PUT_REG'.
;    106          0345  1     no_brackets         = 1;
;    107          0346  1
;    108          0347  1 !
;    109          0348  1 ! OWN storage for up-level references
;    110          0349  1 !
;    111          0350  1
;    112          0351  1 OWN
;    113          0352  1     user_symbolize_routine,                  ! Address of user symbolize routine
;    114          0353  1     user_buffer_address,                     ! Address of user buffer storage
;    115          0354  1     user_buffer_size:   WORD,                ! Size of user buffer
;    116          0355  1     user_buffer_left:   WORD,                ! # bytes left in user buffer to fill
;    117          0356  1     last_literal_value;                      ! Value of last operand
;    118          0357  1
;    119          0358  1 !
;    120          0359  1 ! Macro to invoke a command, and return if the resultant value is an error
;    121          0360  1 !
```

```
:   122             0361   1
:   123             0362   1 MACRO
:   124           M 0363   1     return_if_error(command) =
:   125           M 0364   1         BEGIN
:   126           M 0365   1         LOCAL
:   127           M 0366   1             status;
:   128           M 0367   1
:   129           M 0368   1         status = command;
:   130           M 0369   1         IF NOT .status
:   131           M 0370   1         THEN
:   132           M 0371   1             RETURN .status;
:   133             0372   1         END%;
:   134             0373   1
:   135             0374   1 !
:   136             0375   1 ! Macro to probe read accessibility of a data segment
:   137             0376   1 !
:   138             0377   1
:   139             0378   1 MACRO
:   140           M 0379   1     probe(address,length) =
:   141           M 0380   1         BEGIN
:   142           M 0381   1 !       BUILTIN PROBER;
:   143           M 0382   1 !       IF NOT PROBER(%REF(0),%REF(length),address)
:   144           M 0383   1 !       THEN
:   145           M 0384   1 !           RETURN lib$_accvio;
:   146           M 0385   1         true
:   147             0386   1         END%;
:   148             0387   1
:   149             0388   1 !
:   150             0389   1 ! Macro to append a string to the output buffer
:   151             0390   1 !
:   152             0391   1
:   153             0392   1 MACRO
:   154           M 0393   1     append(string) =
:   155           M 0394   1         append_string(%CHARCOUNT(string),UPLIT BYTE(string)
:   156             0395   1         %IF %LENGTH GTR 1 %THEN ,%REMAINING %FI)%;
:   157             0396   1 !
:   158             0397   1 ! External storage
:   159             0398   1 !
:   160             0399   1
:   161             0400   1 EXTERNAL
:   162             0401   1     lib$gb_opinfo: opcode_tbl;          ! Table describing VAX instruction set
:   163             0402   1
:   164             0403   1 !
:   165             0404   1 ! Define message codes
:   166             0405   1 !
:   167             0406   1
:   168             0407   1 LITERAL
:   169             0408   1     lib$_accvio = 0,
:   170             0409   1     lib$_noinstran = 2,
:   171             0410   1     lib$_numtrunc = 4;
```

```
1 GLOBAL ROUTINE lib$ins_decode(stream_pntr, outbuf, retlen, symbolize_rtn) =
1
1 !---
1 !
1 !       This routine examines a byte stream that it is passed
1 !       a pointer to, and tries to output what instructions
1 !       this corresponds to symbolically.
1 !
1 ! Inputs:
1 !
1 !       stream_ptnr = Address of a byte pointer to the instruction stream.
1 !       outbuf = Address of a buffer descriptor to receive the
1 !                       decoded instruction
1 !       symbolize_rtn = Address of a routine to call to convert an address
1 !
1 !
1 ! Outputs:
1 !
1 !       R0 = status code
1 !       The stream_pntr is updated to point to the next instruction.
1 !--
1
2 BEGIN
2
2 BUILTIN
2     NULLPARAMETER;
2
2 MAP
2     stream_pntr: REF VECTOR [,LONG],
2     outbuf:      REF BLOCK [,BYTE],
2     retlen:      REF VECTOR [,WORD];
2
2 GLOBAL REGISTER
2     stream_ptr=11: REF VECTOR[,BYTE];    ! Points to the instruction stream
2
2 LOCAL
2     opcode: WORD;                        ! Instruction opcode
2
2 stream_ptr = .stream_pntr [0];           ! Get pointer to instruction stream
2
2 user_buffer_size = .outbuf [dsc$w_length];
2 user_buffer_address = .outbuf [dsc$a_pointer];
2 user_buffer_left = .user_buffer_size;
2
2 IF NULLPARAMETER(4)                      ! If 4th parameter unspecified,
2 THEN
2     user_symbolize_routine = 0           ! then set no routine
2 ELSE
2     user_symbolize_routine = .symbolize_rtn;
2
2 probe(.stream_ptr,1);                    ! Exit if we can't read the opcode
2
2 !
2 !  Pick up the opcode and it check for validity.
2 !
2
2 opcode = .stream_ptr [0];                ! Get first byte of opcode
2
```

```
:  230        0468  2 IF .opcode EQL %X'FD'                   ! Check to see if 2 byte opcode
:  231        0469  2 THEN
:  232        0470  3     BEGIN                               ! It is. Get the next byte of opcode.
:  233        0471  3     opcode = .stream_ptr [1]^8 + .opcode;
:  234        0472  3     stream_ptr = .stream_ptr + 1;
:  235        0473  2     END;
:  236        0474  2
:  237        0475  2 IF .opcode EQL %X'FF'                   ! If bugcheck opcode,
:  238        0476  2     AND .stream_ptr [1] EQL %X'FE'
:  239        0477  2 THEN
:  240        0478  3     BEGIN
:  241        0479  3     probe(.stream_ptr,4);               ! Make sure all 4 bytes are readable
:  242        0480  3     append('BUG_CHECK #');
:  243        0481  3     append_hex(.(.stream_ptr+2)<0,16,0>,2);
:  244        0482  3     stream_pntr [0] = .stream_ptr+4;    ! Point to next instruction
:  245        0483  3     IF NOT NULLPARAMETER(3)             ! If RETLEN specified,
:  246        0484  3     THEN
:  247        0485  3         retlen [0] = .user_buffer_size - .user_buffer_left;
:  248        0486  3     RETURN ss$_normal;
:  249        0487  2     END;
:  250        0488  2
:  251        0489  2 IF .lib$gb_opinfo[.opcode, op_numops] EQL not_an_op ! If unknown opcode,
:  252        0490  2 THEN
:  253        0491  2     RETURN lib$_noinstran;              ! Unable to translate instruction
:  254        0492  2
:  255        0493  2 !
:  256        0494  2 ! Bump the instruction pointer up past the opcode,
:  257        0495  2 ! and output the character sequence which corresponds to it.
:  258        0496  2 !
:  259        0497  2
:  260        0498  2 stream_ptr = .stream_ptr + 1;
:  261        0499  2
:  262        0500  2 append_rad50(op_ch_size/3, lib$gb_opinfo [.opcode, op_name]);
:  263        0501  2 append('  ');
:  264        0502  2
:  265        0503  2 !
:  266        0504  2 ! Loop, encoding how each operand is referenced.
:  267        0505  2 !
:  268        0506  2
:  269        0507  2 INCR I FROM 1 TO .lib$gb_opinfo [.opcode, op_numops]
:  270        0508  2 DO
:  271        0509  3     BEGIN
:  272        0510  3     return_if_error(ins_operand(.i, .opcode));
:  273        0511  3
:  274        0512  3     IF .i NEQ 0 AND .i LSS .lib$gb_opinfo [.opcode, op_numops]
:  275        0513  3     THEN
:  276        0514  3         append(',');
:  277        0515  2     END;
:  278        0516  2
:  279        0517  2 !
:  280        0518  2 ! For CASE instructions, increment the stream pointer past the
:  281        0519  2 ! last offset in the list.
:  282        0520  2 !
:  283        0521  2
:  284        0522  2 IF .opcode EQL op_caseb                 ! If CASE instruction,
:  285        0523  2     OR .opcode EQL op_casew
:  286        0524  2     OR .opcode EQL op_casel
```

```
;   287          0525  2 THEN
;   288          0526  2     stream_ptr = .stream_ptr + (.last_literal_value+1)*2;
;   289          0527  2
;   290          0528  2 !
;   291          0529  2 !  Return a pointer to the beginning of the next instruction.
;   292          0530  2 !
;   293          0531  2
;   294          0532  2 IF NOT NULLPARAMETER(3)                    ! If RETLEN specified,
;   295          0533  2 THEN
;   296          0534  2     retlen [0] = .user_buffer_size - .user_buffer_left;
;   297          0535  2
;   298          0536  2 stream_pntr [0] = .stream_ptr;            ! Return pointer to next instruction
;   299          0537  2
;   300          0538  2 RETURN ss$_normal;
;   301          0539  2
;   302          0540  1 END;


                                                                             .TITLE  LIB$INS_DECODE Instruction decoder
                                                                             .IDENT  \V04-000\

                                                                             .PSECT  Z$DEBUG_CODE,  PIC,2

                                                              00000 USER_SYMBOLIZE_ROUTINE:
                                                                             .BLKB   4
                                                              00004 USER_BUFFER_ADDRESS:
                                                                             .BLKB   4
                                                              00008 USER_BUFFER_SIZE:
                                                                             .BLKB   2
                                                              0000A USER_BUFFER_LEFT:
                                                                             .BLKB   2
                                                              0000C LAST_LITERAL_VALUE:
                                                                             .BLKB   4
                 23  20  4B  43  45  48  43  5F  47  55  42   00010 P.AAA:   .ASCII  \BUG_CHECK #\                               ;
                                                     20  20   0001B P.AAB:   .ASCII  \  \                                        ;
                                                         2C   0001D P.AAC:   .ASCII  \,\                                         ;

                                                                             .EXTRN  LIB$GB_OPINFO, LIB$GB_OPINFO1
                                                                             .EXTRN  LIB$GB_OPINFO2

                                                         OFFC 00000          .ENTRY  LIB$INS_DECODE, Save R2,R3,R4,R5,R6,R7,R8,- ; 0411
                                                                                     R9,R10,R11                                  ;
                                         59     0000V  CF  9E 00002          MOVAB   APPEND_STRING, R9                           ;
                                         58 00000000G  EF  9E 00007          MOVAB   LIB$GB_OPINFO2, R8                          ;
                                         57 00000000G  EF  9E 0000E          MOVAB   LIB$GB_OPINFO1, R7                          ;
                                         56        D2  AF  9E 00015          MOVAB   USER_BUFFER_SIZE, R6                        ;
                                         5B        04  BC  D0 00019          MOVL    @STREAM_PNTR, STREAM_PTR                    ; 0448
                                         50        08  AC  D0 0001D          MOVL    OUTBUF, R0                                  ; 0450
                                         66            60  B0 00021          MOVW    (R0), USER_BUFFER_SIZE                      ;
                                    FC   A6        04  A0  D0 00024          MOVL    4(R0), USER_BUFFER_ADDRESS                  ; 0451
                                    02   A6            66  B0 00029          MOVW    USER_BUFFER_SIZE, USER_BUFFER_LEFT          ; 0452
                                         04            6C  91 0002D          CMPB    (AP), #4                                    ; 0454
                                                       05  1F 00030          BLSSU   1$                                          ;
                                                   10  AC  D5 00032          TSTL    16(AP)                                      ;
                                                       05  12 00035          BNEQ    2$                                          ;
                                                   F8  A6  D4 00037 1$:      CLRL    USER_SYMBOLIZE_ROUTINE                      ; 0456
                                                       05  11 0003A          BRB     3$                                          ;
```

```
                                  F8    A6        10        AC D0 0003C 2$:   MOVL    SYMBOLIZE_RTN, USER_SYMBOLIZE_ROUTINE         ; 0458
                                        54                  6B 9B 00041 3$:   MOVZBW  (STREAM_PTR), OPCODE                          ; 0466
                                00FD    8F                  54 B1 00044       CMPW    OPCODE, #253                                  ; 0468
                                                            0D 12 00049       BNEQ    4$                                            :
                                        50        01        AB 9A 0004B       MOVZBL  1(STREAM_PTR), R0                             ; 0471
                    50                  50                  08 78 0004F       ASHL    #8, R0, R0                                    :
                                        54                  50 A0 00053       ADDW2   R0, OPCODE                                    :
                                                            5B D6 00056       INCL    STREAM_PTR                                    ; 0472
                                        52                  54 3C 00058 4$:   MOVZWL  OPCODE, R2                                    ; 0475
                                00FF    8F                  52 B1 0005B       CMPW    R2, #255                                      :
                                                            33 12 00060       BNEQ    6$                                            :
                                  FE    8F        01        AB 91 00062       CMPB    1(STREAM_PTR), #254                           ; 0476
                                                            2C 12 00067       BNEQ    6$                                            :
                                        51        08        A6 9E 00069       MOVAB   P.AAA, R1                                     ; 0480
                                        50                  0B D0 0006D       MOVL    #11, R0                                       :
                                                            69 16 00070       JSB     APPEND_STRING                                 :
                                                            02 DD 00072       PUSHL   #2                                            ; 0481
                                        7E        02        AB 3C 00074       MOVZWL  2(STREAM_PTR), -(SP)                          :
                               0000V    CF                  02 FB 00078       CALLS   #2, APPEND_HEX                                :
                                  04    BC        04        AB 9E 0007D       MOVAB   4(R11), @STREAM_PNTR                          ; 0482
                                        03                  6C 91 00082       CMPB    (AP), #3                                      ; 0483
                                                            0B 1F 00085       BLSSU   5$                                            :
                                                  0C        AC D5 00087       TSTL    12(AP)                                        :
                                                            06 13 0008A       BEQL    5$                                            :
            0C      BC                  66        02        A6 A3 0008C       SUBW3   USER_BUFFER_LEFT, USER_BUFFER_SIZE, @RETLEN   ; 0485
                                                          00FA 31 00092 5$:   BRW     21$                                           ; 0486
                                        51                  04 D0 00095 6$:   MOVL    #4, OFFSET                                    ; 0489
                                                            53 D4 00098       CLRL    R3                                            :
                                  FD    8F                  52 91 0009A       CMPB    R2, #253                                      :
                                                            0B 13 0009E       BEQL    7$                                            :
                                                            53 D6 000A0       INCL    R3                                            :
                                        50                6142 7E 000A2       MOVAQ   (OFFSET)[R2], R0                              :
                                        50                  57 C0 000A6       ADDL2   R7, R0                                        :
                                                            0C 11 000A9       BRB     8$                                            :
                    50                  52        F8        8F 78 000AB 7$:   ASHL    #-8, R2, R0                                   :
                                        50                6140 7E 000B0       MOVAQ   (OFFSET)[R0], R0                              :
                                        50                  58 C0 000B4       ADDL2   R8, R0                                        :
    0F              60                  04                  00 ED 000B7 8$:   CMPZV   #0, #4, (R0), #15                             :
                                                            04 12 000BC       BNEQ    9$                                            :
                                        50                  02 D0 000BE       MOVL    #2, R0                                        ; 0491
                                                               04 000C1       RET                                                   :
                                                            5B D6 000C2 9$:   INCL    STREAM_PTR                                    ; 0498
                                                            51 D4 000C4       CLRL    OFFSET                                        ; 0500
                                        09                  53 E9 000C6       BLBC    R3, 10$                                       :
                                        50                6142 7E 000C9       MOVAQ   (OFFSET)[R2], R0                              :
                                        50                  57 C0 000CD       ADDL2   R7, R0                                        :
                                                            0C 11 000D0       BRB     11$                                           :
                    50                  52        F8        8F 78 000D2 10$:  ASHL    #-8, R2, R0                                   :
                                        50                6140 7E 000D7       MOVAQ   (OFFSET)[R0], R0                              :
                                        50                  58 C0 000DB       ADDL2   R8, R0                                        :
                                                            50 DD 000DE 11$:  PUSHL   R0                                            :
                                                            02 DD 000E0       PUSHL   #2                                            :
                               0000V    CF                  02 FB 000E2       CALLS   #2, APPEND_RAD50                              :
                                        51        13        A6 9E 000E7       MOVAB   P.AAB, R1                                     ; 0501
                                        50                  02 D0 000EB       MOVL    #2, R0                                        :
                                                            69 16 000EE       JSB     APPEND_STRING                                 :
                                        51                  04 D0 000F0       MOVL    #4, OFFSET                                    ; 0507
```

```
                                                      52             54 3C 000F3        MOVZWL   OPCODE, R2
                                                                     55 D4 000F6        CLRL     R5
                                                FD    8F             52 91 000F8        CMPB     R2, #253
                                                                     0B 13 000FC        BEQL     12$
                                                                     55 D6 000FE        INCL     R5
                                                      50           6142 7E 00100        MOVAQ    (OFFSET)[R2], R0
                                                      50             57 C0 00104        ADDL2    R7, R0
                                                                     0C 11 00107        BRB      13$
                                    50                52        F8   8F 78 00109 12$:   ASHL     #-8, R2, R0
                                                      50           6140 7E 0010E        MOVAQ    (OFFSET)[R0], R0
                                                      50             58 C0 00112        ADDL2    R8, R0
              54                    60                04             00 EF 00115 13$:   EXTZV    #0, #4, (R0), R4
                                                                     53 D4 0011A        CLRL     I
                                                                     3B 11 0011C        BRB      17$
                                                                     52 DD 0011E 14$:   PUSHL    R2                                          ; 0510
                                                                     53 DD 00120        PUSHL    I
                                             0000V    CF             02 FB 00122        CALLS    #2, INS_OPERAND
                                                      68             50 E9 00127        BLBC     STATUS, 22$
                                                                     53 D5 0012A        TSTL     I                                           ; 0512
                                                                     2B 13 0012C        BEQL     17$
                                                      51             04 D0 0012E        MOVL     #4, OFFSET
                                                      09             55 E9 00131        BLBC     R5, 15$
                                                      50           6142 7E 00134        MOVAQ    (OFFSET)[R2], R0
                                                      50             57 C0 00138        ADDL2    R7, R0
                                                                     0C 11 0013B        BRB      16$
                                    50                52        F8   8F 78 0013D 15$:   ASHL     #-8, R2, R0
                                                      50           6140 7E 00142        MOVAQ    (OFFSET)[R0], R0
                                                      50             58 C0 00146        ADDL2    R8, R0
              53                    60                04             00 ED 00149 16$:   CMPZV    #0, #4, (R0), I
                                                                     09 15 0014E        BLEQ     17$
                                                      51        15   A6 9E 00150        MOVAB    P.AAC, R1                                   ; 0514
                                                      50             01 D0 00154        MOVL     #1, R0
                                                                     69 16 00157        JSB      APPEND_STRING
                                    C1                53             54 F3 00159 17$:   AOBLEQ   R4, I, 14$                                  ; 0507
                                              008F    8F             52 B1 0015D        CMPW     R2, #143                                    ; 0522
                                                                     0E 13 00162        BEQL     18$
                                              00AF    8F             52 B1 00164        CMPW     R2, #175                                    ; 0523
                                                                     07 13 00169        BEQL     18$
                                              00CF    8F             52 B1 0016B        CMPW     R2, #207                                    ; 0524
                                                                     09 12 00170        BNEQ     19$
                                                      50        04   A6 D0 00172 18$:   MOVL     LAST_LITERAL_VALUE, R0                      ; 0526
                                                      5B        02 AB40 3E 00176        MOVAW    2(STREAM_PTR)[R0], STREAM_PTR
                                                      03             6C 91 0017B 19$:   CMPB     (AP), #3                                    ; 0532
                                                                     0B 1F 0017E        BLSSU    20$
                                                                0C   AC D5 00180        TSTL     12(AP)
                                                                     06 13 00183        BEQL     20$
                            0C      BC                66        02   A6 A3 00185        SUBW3    USER_BUFFER_LEFT, USER_BUFFER_SIZE, @RETLEN ; 0534
                                                04    BC             5B D0 0018B 20$:   MOVL     STREAM_PTR, @STREAM_PNTR                    ; 0536
                                                      50             01 D0 0018F 21$:   MOVL     #1, R0                                      ; 0538
                                                                        04 00192 22$:   RET                                                  ; 0540

; Routine Size:  403 bytes,    Routine Base:  Z$DEBUG_CODE + 001E
```

```
1 %SBTTL 'INS_OPERAND - Output instruction''s operand'
1 ROUTINE ins_operand(index, opcode): ptr_linkage =
1
1 !---
1 !
1 !       Print out a reference to an instruction operand.
1 !
1 ! Warning:
1 !
1 !       1) there is code in the 'deferred' macro which will cease
1 !          to work when/if we change the representation of true
1 !          and false.
1 !       2) the local macros, below, check for the indicated addressing
1 !          modes only given that they appear in the code where they
1 !          do - ie, the checks take advantage of what we know about
1 !          which cases we have already eliminated, etc.
1 !
1 ! Inputs:
1 !
1 !       stream_ptr = a byte pointer to the first byte of the instruction
1 !                    stream which begins the reference to this operand.
1 !                    this byte is what we refer to as the dominant mode.
1 !       index = ordinal of which operand we are on.  this is needed to
1 !                    decide the 'context' for this operand if pc-relative
1 !                    addressing mode is used.
1 !       opcode = The opcode we are currently working on.
1 !               (This parameter has already been validated.)
1 !
1 ! Outputs:
1 !
1 !       R0 = status code
1 !       The stream_ptr is incremented to reflect how much of the instruction
1 !       stream we have 'eaten up'.  This pointer should point to the beginning
1 !       of either the next instruction, or the next operand reference,
1 !       depending on how many operands the current instruction has.
1 !---
1
2 BEGIN
2
2 !
2 ! Local macros used to check for the indicated addressing modes.
2 !
2
2 MACRO
2     registr(mode)                 ! register mode addressing.
2         = (mode EQL 5) %,
2     deferred(mode)                ! those which begin with '@' are
2         = (mode LSS 0 AND mode)%, !
2                                   !  9 - @(rn)+,
2                                   !  b - @byte(rn),
2                                   !  d - @word(rn),
2                                   !  f - @long(rn),
2                                   ! or any of these + indexing.
2                                   ! the thing which is common to only these
2                                   ! modes is that they all have the sign
2                                   ! bit set and are odd!
2
2     autodec(mode)                 ! see if mode is auto decrement.
```

```
2               = (mode EQL 7)%,        ! this check is right from srm.
2
2         autoinc(mode)                 ! mode is auto increment
2             = (mode LSS 0)%;
2                                       ! this check depends upon the fact that
2                                       ! we extracted the mode with sign extension,
2                                       ! and that we have already eliminated
2                                       ! many of the other possibilities.
2
2     EXTERNAL REGISTER
2         stream_ptr=11: REF BLOCK [,BYTE];   ! Points to the instruction stream
2
2     LOCAL
2         flag,                         ! indicates which type of displacment we have.
2         displ,                        ! the actual displacement.
2         disp_size,                    ! the size, in bytes, of a displacement.
2         dom_oprnd,                    ! operand which we extract from the
2                                       !  dominant mode byte.  it may be rn,
2                                       !  rx, or a literal.  (srm notation).
2         dom_mode;                     ! the primary addressing mode comes from
2                                       !     this dominant byte as well.
2
2     !
2     ! We have to consider the possibility of
2     ! so-called 'branch type' addressing first
2     ! before anything else because otherwise you cannot
2     ! differentiate short literal from byte displacement
2     ! branching.
2     !
2
2     IF branch_type(.index, .opcode)         ! If we can output branch operand,
2     THEN
2         RETURN ss$_normal;                  ! Return with updated stream pointer
2
2     !
2     ! See that we can access at least the operand byte.
2     !
2
2     probe(.stream_ptr, 1);                  ! Return if we can't read the operand
2
2     !
2     ! Extract the needed fields from the first byte of
2     !  the operand specifier.  We extract some fields
2     !  with sign extension simply because that makes
2     !  making various tests more convenient.
2     !
2
2     dom_mode = .stream_ptr [amode];
2     dom_oprnd = .stream_ptr [areg];
2
2     !
2     ! Take special action for indexing mode.
2     !
2
2     IF .dom_mode EQL indexing_mode
2     THEN
3         BEGIN
```

```
3      ! handle indexing mode recursively.
3
3      stream_ptr = stream_ptr [next_field(1)];
3      return_if_error(ins_operand(.index, .opcode));
3      put_reg(.dom_oprnd, square_brackets);
3      RETURN ss$_normal;
2      END;
2
2  ! Simple modes are easier:
2
2  ! First see if there will be a literal or displacement in the operand.
2
2  return_if_error(displacement(flag, displ, disp_size, .index, .opcode));
2
2  ! Begin checking for the addressing modes which begin
2  ! with special characters since we have to print them
2  ! first.  We try to handle similar cases with the same
2  ! code, getting the differences out of the way first.
2
3  IF deferred(.dom_mode)
2  THEN
2      append('@')
2  ELSE
3      IF autodec(.dom_mode)
2      THEN
2          append('-');
2
2  ! Next we have to consider displacements or literals.
2  ! Whether or not this is the case has already been
2  ! determined in the call to 'displacement', above.
2
2  IF .flag
2  THEN
3      BEGIN
3        ! There is a literal, so print it.
3        ! The flag value returned by displacement()
3        ! distinguishes when there should be a '#',
3        ! as opposed to when the number is actually
3        ! a displacement off a register.
3
3      IF .flag GTR 0                          ! If its a literal,
3      THEN
4          BEGIN
4          append('#');
4
4            ! except for @# mode, Make .dom_oprnd neq pc_reg so that
4            ! later only checking that will also tell us
4            ! that .flag is gtr 0.
4
5          IF not deferred(.dom_mode)
4          THEN
4              dom_oprnd = pc_reg +1;
4  !       END
4  !    ELSE                                   ! Else, for displacements,
4  !       BEGIN
4  !       OWN
4  !           displ_id: VECTOR[4,BYTE]
```

```
;   475          0712   4 !                        INITIAL( BYTE( 'B', 'W', '?', 'L') );
;   476          0713   4 !
;   477          0714   4 !         ! Print an indication of the displacement size.
;   478          0715   4 !
;   479          0716   4 !         append_string(1, displ_id [.disp_size-1]);
;   480          0717   4 !         append('^');
;   481          0718   3           END;
;   482          0719   3
;   483          0720   3       ! Output here is always "displ(reg)", for non-PC
;   484          0721   3       ! displacments, and just "effective", otherwise.
;   485          0722   3
;   486          0723   3       IF .dom_oprnd EQL pc_reg                    ! If PC relative or absolute,
;   487          0724   3       THEN
;   488          0725   4           BEGIN
;   489          0726   4           IF .flag LSS 0                          ! If PC relative,
;   490          0727   4           THEN
;   491          0728   5               BEGIN
;   492          0729   5               disp_size = 4;
;   493          0730   5               displ = .displ + .stream_ptr;       ! Make an effective address
;   494          0731   5               append_address(.displ, 0);          ! Output relative address
;   495          0732   5               END
;   496          0733   4           ELSE                                    ! Else, if absolute address,
;   497          0734   4               append_address(.displ, 1);          ! Output absolute address
;   498          0735   4           END
;   499          0736   3       ELSE
;   500          0737   4           BEGIN
;   501          0738   4
;   502          0739   4           ! Literals or real (non-PC) displacement modes.
;   503          0740   4
;   504          0741   4           append_hex(.displ, .disp_size);         ! Output literal or offset,
;   505          0742   4           last_literal_value = .displ;            ! Save last literal value
;   506          0743   4
;   507          0744   4           IF .flag LSS 0                          ! If relative (from register),
;   508          0745   4           THEN
;   509          0746   4               put_reg(.dom_oprnd, round_brackets);
;   510          0747   3           END;
;   511          0748   3       END
;   512          0749   3
;   513          0750   3   ! No literal or displacement -> we must have some type of
;   514          0751   3   ! register reference.  Sort out the few cases and print them.
;   515          0752   3
;   516          0753   2   ELSE
;   517          0754   3       IF registr(.dom_mode)
;   518          0755   2       THEN
;   519          0756   2           put_reg(.dom_oprnd, no_brackets)
;   520          0757   2       ELSE
;   521          0758   3           BEGIN
;   522          0759   3           put_reg(.dom_oprnd, round_brackets);
;   523          0760   4           IF autoinc(.dom_mode)
;   524          0761   3           THEN
;   525          0762   3               append('+');
;   526          0763   2           END;
;   527          0764   2
;   528          0765   2   RETURN ss$_normal;
;   529          0766   2
;   530          0767   1   END;
```

```
                                               40 001B1 P.AAD:  .ASCII  \@\                                     ;
                                               2D 001B2 P.AAE:  .ASCII  \-\                                     ;
                                               23 001B3 P.AAF:  .ASCII  \#\                                     ;
                                               2B 001B4 P.AAG:  .ASCII  \+\                                     ;


                                             07FC 00000 INS_OPERAND:
                                                                .WORD   Save R2,R3,R4,R5,R6,R7,R8,R9,R10        ; 0542
                             56     0000V   CF 9E 00002         MOVAB   APPEND_STRING, R6                       ;
                             55        F6   AF 9E 00007         MOVAB   INS_OPERAND, R5                         ;
                             5E             0C C2 0000B         SUBL2   #12, SP                                 ;
                             7E        04   AC 7D 0000E         MOVQ    INDEX, -(SP)                            ; 0628
                      0000V  CF             02 FB 00012         CALLS   #2, BRANCH_TYPE                         ;
                             03             50 E9 00017         BLBC    R0, 1$                                  ;
                                          0000 31 0001A         BRW     16$                                     ;
52            6B             04             04 EE 0001D 1$:     EXTV    #4, #4, (STREAM_PTR), DOM_MODE          ; 0645
54            6B             04             00 EF 00022         EXTZV   #0, #4, (STREAM_PTR), DOM_OPRND         ; 0646
                             04             52 D1 00027         CMPL    DOM_MODE, #4                            ; 0652
                                            11 12 0002A         BNEQ    2$                                      ;
                                            5B D6 0002C         INCL    STREAM_PTR                              ; 0657
                             7E        04   AC 7D 0002E         MOVQ    INDEX, -(SP)                            ; 0658
                             65             02 FB 00032         CALLS   #2, INS_OPERAND                         ;
                             17             50 E9 00035         BLBC    STATUS, 3$                              ;
                                            02 DD 00038         PUSHL   #2                                      ; 0659
                                          0091 31 0003A         BRW     14$                                     ;
                             7E        04   AC 7D 0003D 2$:     MOVQ    INDEX, -(SP)                            ; 0667
                                       08   AE 9F 00041         PUSHAB  DISP_SIZE                               ;
                                       10   AE 9F 00044         PUSHAB  DISP[                                   ;
                                       18   AE 9F 00047         PUSHAB  FLAG                                    ;
                      0000V  CF             05 FB 0004A         CALLS   #5, DISPLACEMENT                        ;
                             01             50 E8 0004F 3$:     BLBS    STATUS, 4$                              ;
                                               04 00052         RET                                             ;
                                            53 D4 00053 4$:     CLRL    R3                                      ; 0674
                                            52 D5 00055         TSTL    DOM_MODE                                ;
                                            0B 18 00057         BGEQ    5$                                      ;
                                            53 D6 00059         INCL    R3                                      ;
                             06             52 E9 0005B         BLBC    DOM_MODE, 5$                            ;
                             51        9B   AF 9E 0005E         MOVAB   P.AAD, R1                               ; 0676
                                            09 11 00062         BRB     6$                                      ;
                             07             52 D1 00064 5$:     CMPL    DOM_MODE, #7                            ; 0678
                                            09 12 00067         BNEQ    7$                                      ;
                             51        91   AF 9E 00069         MOVAB   P.AAE, R1                               ; 0680
                             50             01 D0 0006D 6$:     MOVL    #1, R0                                  ;
                                            66 16 00070         JSB     APPEND_STRING                           ;
                             51        08   AE E9 00072 7$:     BLBC    FLAG, 13$                               ; 0686
                                       08   AE D5 00076         TSTL    FLAG                                    ; 0695
                                            12 15 00079         BLEQ    9$                                      ;
                             51        80   AF 9E 0007B         MOVAB   P.AAF, R1                               ; 0698
                             50             01 D0 0007F         MOVL    #1, R0                                  ;
                                            66 16 00082         JSB     APPEND_STRING                           ;
                             03             53 E9 00084         BLBC    R3, 8$                                  ; 0704
                             03             52 E8 00087         BLBS    DOM_MODE, 9$                            ;
                             54             10 D0 0008A 8$:     MOVL    #16, DOM_OPRND                          ; 0706
                             0F             54 D1 0008D 9$:     CMPL    DOM_OPRND, #15                          ; 0723
```

```
                                                       1C  12 00090          BNEQ     12$                                            ;
                                                 08    AE  D5 00092          TSTL     FLAG                                           ; 0726
                                                       0B  18 00095          BGEQ     10$                                            ;
                                        6E             04  D0 00097          MOVL     #4, DISP_SIZE                                  ; 0729
                                   04   AE             5B  C0 0009A          ADDL2    STREAM_PTR, DISPL                              ; 0730
                                                       7E  D4 0009E          CLRL     -(SP)                                          ; 0731
                                                       02  11 000A0          BRB      11$                                            ;
                                                       01  DD 000A2 10$:     PUSHL    #1                                             ; 0734
                                                 08    AE  DD 000A4 11$:     PUSHL    DISPL                                          ;
                                 0000V  CF             02  FB 000A7          CALLS    #2, APPEND_ADDRESS                             ;
                                                       3F  11 000AC          BRB      16$                                            ; 0723
                                                       6E  DD 000AE 12$:     PUSHL    DISP_SIZE                                      ; 0741
                                                 08    AE  DD 000B0          PUSHL    DISPL                                          ;
                                 0000V  CF             02  FB 000B3          CALLS    #2, APPEND_HEX                                 ;
                                 FD99   CF       04    AE  D0 000B8          MOVL     DISPL, LAST_LITERAL_VALUE                      ; 0742
                                                 08    AE  D5 000BE          TSTL     FLAG                                           ; 0744
                                                       2A  18 000C1          BGEQ     16$                                            ;
                                                       7E  D4 000C3          CLRL     -(SP)                                          ; 0746
                                                       07  11 000C5          BRB      14$                                            ;
                                        05             52  D1 000C7 13$:     CMPL     DOM_MODE, #5                                   ; 0754
                                                       0B  12 000CA          BNEQ     15$                                            ;
                                                       01  DD 000CC          PUSHL    #1                                             ; 0756
                                                       54  DD 000CE 14$:     PUSHL    DOM_OPRND                                      ;
                                 0000V  CF             02  FB 000D0          CALLS    #2, PUT_REG                                    ;
                                                       16  11 000D5          BRB      16$                                            ;
                                                       7E  D4 000D7 15$:     CLRL     -(SP)                                          ; 0759
                                                       54  DD 000D9          PUSHL    DOM_OPRND                                      ;
                                 0000V  CF             02  FB 000DB          CALLS    #2, PUT_REG                                    ;
                                        0A             53  E9 000E0          BLBC     R3, 16$                                        ; 0760
                                        51     FF18    CF  9E 000E3          MOVAB    P.AAG, R1                                      ; 0762
                                        50             01  D0 000E8          MOVL     #1, R0                                         ;
                                                       66  16 000EB          JSB      APPEND_STRING                                  ;
                                        50             01  D0 000ED 16$:     MOVL     #1, R0                                         ; 0765
                                                           04 000F0          RET                                                     ; 0767

; Routine Size:  241 bytes,    Routine Base:  Z$DEBUG_CODE + 01B5
```

```
1 %SBTTL 'BRANCH_TYPE - Handle branch operands'
1 ROUTINE branch_type(index, opcode): ptr_linkage =
1
1 !---
1 !
1 !       Decide if the current operand is using branch type
1 !       addressing.  If so, print out the reference and
1 !       look after all the details.  Otherwise return 0
1 !       and let someone else handle it.
1 !
1 ! Inputs:
1 !
1 !       stream_ptr = a pointer to the current dominant mode byte.
1 !       index = which operand (ordinal) we're working on.
1 !       opcode = The opcode we are currently working on.
1 !               (This parameter has already been validated.)
1 !
1 ! Routine value:
1 !
1 !       Routine value is true if the current operand is a branch, else false.
1 !
1 !       If the current operand is a branch, the reference is appended
1 !       to the output buffer and the stream pointer is updated.
1 !--
1
2 BEGIN
2
2 EXTERNAL REGISTER
2     stream_ptr=11;                        ! Points to the instruction stream
2
2 LOCAL
2     n_ops,                                ! number of operands for current opcode
2     disp_size,                            ! size of branch operand, in bytes.
2     displ;                                ! the actual branch displacement.
2
2 ! There is no point in even considering branch type
2 ! addressing unless we're on the last operand for
2 ! this instruction.
2
2 n_ops = .lib$gb_opinfo [.opcode, op_numops];
2
2 IF .n_ops NEQ .index
2 THEN
2     RETURN false;
2
2 ! Now we know we can take the op_br_type field literally.
2 ! it contains the number of bytes used for the branch
2 ! displacement.  0 in this field indicates that
2 ! this opcode has no branch type operands.
2
2 disp_size = .lib$gb_opinfo [.opcode, op_br_type];
2
2 IF .disp_size EQL no_branch
2 THEN
2     RETURN false;
2
2 probe(.stream_ptr,.disp_size);            ! Exit if we can't read displacement
2
```

```
:  589          0825  2 !
:  590          0826  2 !  Success!  We have discovered a case of branch type addressing.
:  591          0827  2 !  handle this by simply extracting the field, (with sign
:  592          0828  2 !  extension as per srm),  printing out the reference,
:  593          0829  2 !  and returning a pointer to the next instruction.
:  594          0830  2 !
:  595          0831  2
:  596          0832  2 displ = .(.stream_ptr)<0,.disp_size*8,1>;
:  597          0833  2 stream_ptr = .stream_ptr + .disp_size;
:  598          0834  2
:  599          0835  2 append_address(.stream_ptr + .displ, 0); ! Output relative address
:  600          0836  2
:  601          0837  2 RETURN true;
:  602          0838  2
:  603          0839  1 END;



                                          003C 00000 BRANCH_TYPE:
                                                             .WORD    Save R2,R3,R4,R5                         ; 0769
                       55 00000000G   EF   9E 00002          MOVAB    LIB$GB_OPINFO1, R5                       :
                       54 00000000G   EF   9E 00009          MOVAB    LIB$GB_OPINFO2, R4                       :
                       52             04   D0 00010          MOVL     #4, OFFSET                               ; 0806
                       51       08    AC   D0 00013          MOVL     OPCODE, R1                               :
                                      53   D4 00017          CLRL     R3                                       :
                  FD   8F             51   91 00019          CMPB     R1, #253                                 :
                                      0B   13 0001D          BEQL     1$                                       :
                                      53   D6 0001F          INCL     R3                                       :
                       50           6241   7E 00021          MOVAQ    (OFFSET)[R1], R0                         :
                       50             55   C0 00025          ADDL2    R5, R0                                   :
                                      0C   11 00028          BRB      2$                                       :
            50         51       F8    8F   78 0002A 1$:      ASHL     #-8, R1, R0                              :
                       50           6240   7E 0002F          MOVAQ    (OFFSET)[R0], R0                         :
                       50             54   C0 00033          ADDL2    R4, R0                                   :
   50       60         04             00   EF 00036 2$:      EXTZV    #0, #4, (R0), N_OPS                      :
                  04   AC             50   D1 0003B          CMPL     N_OPS, INDEX                             ; 0808
                                      3C   12 0003F          BNEQ     5$                                       :
                       52             07   D0 00041          MOVL     #7, OFFSET                               ; 0817
                       09             53   E9 00044          BLBC     R3, 3$                                   :
                       50           6241   7E 00047          MOVAQ    (OFFSET)[R1], R0                         :
                       50             55   C0 0004B          ADDL2    R5, R0                                   :
                                      0C   11 0004E          BRB      4$                                       :
            50         51       F8    8F   78 00050 3$:      ASHL     #-8, R1, R0                              :
                       50           6240   7E 00055          MOVAQ    (OFFSET)[R0], R0                         :
                       50             54   C0 00059          ADDL2    R4, R0                                   :
   50       60         04             04   EF 0005C 4$:      EXTZV    #4, #4, (R0), DISP_SIZE                  :
                                      1A   13 00061          BEQL     5$                                       ; 0819
            51         50             03   78 00063          ASHL     #3, DISP_SIZE, R1                        ; 0832
   52       6B         51             00   EE 00067          EXTV     #0, R1, (STREAM_PTR), DISPL              :
                       5B             50   C0 0006C          ADDL2    DISP_SIZE, STREAM_PTR                    ; 0833
                                      7E   D4 0006F          CLRL     -(SP)                                    ; 0835
                                    624B   9F 00071          PUSHAB   (DISPL)[STREAM_PTR]                      :
               0000V   CF             02   FB 00074          CALLS    #2, APPEND_ADDRESS                       :
                       50             01   D0 00079          MOVL     #1, R0                                   ; 0837
                                           04 0007C          RET                                               :
```

```
                                50  D4 0007D 5$:      CLRL     R0                                        ; 0839
                                    04 0007F          RET                                                ;

; Routine Size:  128 bytes,    Routine Base:  Z$DEBUG_CODE + 02A6
```

```
%SBTTL 'DISPLACEMENT - Determine size of operand'
ROUTINE displacement (flag, displ, ptr_disp_size, index, opcode): ptr_linkage =

!---
!
!       Return any displacement associated with the current operand of the
!       current instruction. Note that for short literals, the literal is returned
!       in DISPL; for displacement mode instructions, the actual displacement is
!       returned in DISPL; and for PC Mode instructions, the displacement is returned
!       in DISPL. For other mode instructions, the routine effectively No-ops.
!
! Inputs:
!
!       stream_ptr = Where the current operand specifier starts.
!       flag = Where we indicate the displacement type
!       displ = Where we put the actual displacement
!       ptr_disp_size = Number of bytes in the displcaement
!       index = Designates the Current operand
!       opcode = Number of opcode of current instruction
!
!
! Outputs:
!
!       R0 = status code
!       flag = 1 if literal, -1 if displacement, 0 otherwise
!       displ = Displacement or literal value
!       ptr_disp_size = Number of bytes of displacement
!
!       The stream pointer is updated to the next operand or address
!       of the same operand if a displacement wasn't found.
!--

BEGIN

MACRO
    short_literal_mode = (.mode LEQ 3 AND .mode GEQ 0)%,
    displacement_mode = (.mode LEQ 15 AND .mode GEQ 10)%,
    pc_mode = (.reg EQL pc_reg AND (.mode EQL 8 OR .mode EQL 9))%;

EXTERNAL REGISTER
    stream_ptr=11: REF BLOCK [,BYTE];   ! Points to the instruction stream

MAP
    flag:          REF VECTOR,
    displ:         REF BLOCK,
    opcode:        BLOCK,
    ptr_disp_size: REF VECTOR;

LOCAL
    reg,                                ! Register in operand specifier
    mode;                               ! Mode in operand specifier

reg = .stream_ptr [areg];
mode = .stream_ptr [dspl_mode];

! Get past operand specifier byte

stream_ptr = stream_ptr [next_field(1)];
```

```
;  2
;  2 SELECTONE true OF
;  2     SET
;  2     [short_literal_mode]:                   ! Short literal mode
;  3                 BEGIN
;  3                 ! Short literals only allowed on read-only operands
;  3                 IF .lib$gb_opinfo [.opcode, op_datatype(.index)] NEQ access_r
;  3                 THEN
;  3                     RETURN lib$_noinstran; ! then return invalid instruction
;  3                 ! Extract the number from operand specifier
;  3                 displ [0,0,32,0] = .mode<0,2,0>^4 OR .reg;
;  3                 flag [0] = 1;               ! Say its a literal
;  3                 ptr_disp_size [0] = 1;
;  3                 RETURN ss$_normal;
;  2                 END;
;  2     [displacement_mode]:                    ! Displacement modes
;  3                 BEGIN
;  3                 flag [0] = -1;              ! Say its a displacement
;  3                 ptr_disp_size [0] =
;  4                         (CASE .mode FROM 10 TO 15 OF
;  4                                 SET
;  4                                 [12,13]: 2;     ! 2 bytes of displacement info
;  4                                 [14,15]: 4;     ! 4 bytes of displacement info
;  4                                 [INRANGE]: 1;   ! 1 byte of displacement info
;  3                                 TES);
;  3                 ! Save off the displacement
;  3                 block [.displ,0,0,32,0] = .stream_ptr [0,0,8*.ptr_disp_size [0],1];
;  3                 stream_ptr = stream_ptr [next_field(.ptr_disp_size [0])];
;  3                 RETURN ss$_normal;
;  2                 END;
;  2     [pc_mode]:                              ! PC Modes
;  3                 BEGIN
;  3                 flag [0] = 1;               ! Say its a literal
;  3                 IF .mode EQL 9
;  3                 THEN
;  3                     ptr_disp_size [0] = 4       ! 4 bytes of address
;  3                 ! Else amount of displacement is dependent upon instruction
;  3                 ELSE
;  3                     ptr_disp_size [0] = ins_context(.index, .opcode);
;  3                 block [.displ,0,0,32,0] = .stream_ptr [0,0,8*MIN(.ptr_disp_size [0], 4), 0];
;  3                 IF .ptr_disp_size [0] GTR 4
;  3                 THEN
;  3                     RETURN lib$_numtrunc; ! Can't handle quad or octawords yet.
;  3                 stream_ptr = stream_ptr [next_field(.ptr_disp_size [0])];
;  3                 RETURN ss$_normal;
;  2                 END;
;  2     [OTHERWISE]:
;  3                 BEGIN                       ! None of the above, so No op.
;  3                 flag [0] = 0;               ! Not a displacement
;  3                 ptr_disp_size [0] = 0;
;  3                 displ [0,0,32,0] = 0;
;  3                 ! Back over the byte we advanced over earlier
;  3                 stream_ptr = stream_ptr [next_field(0)];
;  3                 RETURN ss$_normal;
;  2                 END;
;  2     TES;
;  719          0954  1 END;



                                            003C 00000 DISPLACEMENT:
                                                             .WORD      Save R2,R3,R4,R5                            ; 0841
54           6B            04             00  EF 00002        EXTZV     #0, #4, (STREAM_PTR), REG                   ; 0891
50           8B            04             04  EF 00007        EXTZV     #4, #4, (STREAM_PTR)+, MODE                 ; 0892
                                          52  D4 0000C        CLRL      R2                                          ; 0900
                           03             50  D1 0000E        CMPL      MODE, #3                                    ;
                                          02  14 00011        BGTR      1$                                          ;
                                          52  D6 00013        INCL      R2                                          ;
                                          51  D4 00015 1$:    CLRL      R1                                          ;
                                          50  D5 00017        TSTL      MODE                                        ;
                                          02  19 00019        BLSS      2$                                          ;
                                          51  D6 0001B        INCL      R1                                          ;
                           53             52  D2 0001D 2$:    MCOML     R2, R3                                      ;
                           51             53  CA 00020        BICL2     R3, R1                                      ;
                           01             51  D1 00023        CMPL      R1, #1                                      ;
                                          63  12 00026        BNEQ      6$                                          ;
             51       10   AC             02  C7 00028        DIVL3     #2, INDEX, R1                               ; 0903
                           51             04  C0 0002D        ADDL2     #4, OFFSET                                  ;
                           52      14     AC  D0 00030        MOVL      OPCODE, R2                                  ;
                      FD   8F             52  91 00034        CMPB      R2, #253                                    ;
                                          0E  13 00038        BEQL      3$                                          ;
                           52           6142  7E 0003A        MOVAQ     (OFFSET)[R2], R2                            ;
                           51  00000000GEF42  9E 0003E        MOVAB     LIB$GB_OPINFO1[R2], R1                      ;
                                          11  11 00046        BRB       4$                                          ;
             52            52      F8     8F  78 00048 3$:    ASHL      #-8, R2, R2                                 ;
                           51           6142  7E 0004D        MOVAQ     (OFFSET)[R2], R1                            ;
                           51  00000000GEF41  9E 00051        MOVAB     LIB$GB_OPINFO2[R1], R1                      ;
53      10   AC            01             00  EF 00059 4$:    EXTZV     #0, #1, INDEX, R3                           ;
                           53             04  C4 0005F        MULL2     #4, R3                                      ;
                           53             03  C0 00062        ADDL2     #3, R3                                      ;
52           61            01             53  EF 00065        EXTZV     R3, #1, (R1), R2                            ;
                           01             52  D1 0006A        CMPL      R2, #1                                      ;
                                          04  13 0006D        BEQL      5$                                          ;
                           50             02  D0 0006F        MOVL      #2, R0                                      ; 0905
                                              04 00072        RET                                                   ;
50           50            02             00  EF 00073 5$:    EXTZV     #0, #2, MODE, R0                            ; 0907
                           50             10  C4 00078        MULL2     #16, R0                                     ;
        08   BC            50             54  C9 0007B        BISL3     REG, R0, @DISPL                             ;
                      04   BC             01  D0 00080        MOVL      #1, @FLAG                                   ; 0908
                      0C   BC             01  D0 00084        MOVL      #1, @PTR_DISP_SIZE                          ; 0909
                                        00C2  31 00088        BRW       23$                                         ; 0910
                                          52  D4 0008B 6$:    CLRL      R2                                          ; 0912
                           0F             50  D1 0008D        CMPL      MODE, #15                                   ;
                                          02  14 00090        BGTR      7$                                          ;
                                          52  D6 00092        INCL      R2                                          ;
                                          51  D4 00094 7$:    CLRL      R1                                          ;
                           0A             50  D1 00096        CMPL      MODE, #10                                   ;
                                          02  19 00099        BLSS      8$                                          ;
                                          51  D6 0009B        INCL      R1                                          ;
                           53             52  D2 0009D 8$:    MCOML     R2, R3                                      ;
                           51             53  CA 000A0        BICL2     R3, R1                                      ;
```

```
                             01        51 D1 000A3       CMPL    R1, #1                                  ;
                                       32 12 000A6       BNEQ    14$                                     ;
                       04    BC        01 CE 000A8       MNEGL   #1, @FLAG                               ; 0914
                05           0A        50 CF 000AC       CASEL   MODE, #10, #5                           ; 0916
000C          000C         0016      0016    000B0 9$:   .WORD   12$-9$,-                                ;
                           0011      0011    000B8               12$-9$,-                                ;
                                                                 10$-9$,-                                ;
                                                                 10$-9$,-                                ;
                                                                 11$-9$,-                                ;
                                                                 11$-9$                                  ;
                             51        02 D0 000BC 10$:  MOVL    #2, R1                                  ;
                                       08 11 000BF       BRB     13$                                     ;
                             51        04 D0 000C1 11$:  MOVL    #4, R1                                  ;
                                       03 11 000C4       BRB     13$                                     ;
                             51        01 D0 000C6 12$:  MOVL    #1, R1                                  ;
                       0C    BC        51 D0 000C9 13$:  MOVL    R1, @PTR_DISP_SIZE                      ;
                51     0C    BC        03 78 000CD       ASHL    #3, @PTR_DISP_SIZE, R1                  ; 0923
  08  BC        6B           51        00 EE 000D2       EXTV    #0, R1, (STREAM_PTR), @DISPL            ;
                                       64 11 000D8       BRB     21$                                     ; 0924
                                       53 D4 000DA 14$:  CLRL    R3                                      ; 0927
                             0F        54 D1 000DC       CMPL    REG, #15                                ;
                                       02 12 000DF       BNEQ    15$                                     ;
                                       53 D6 000E1       INCL    R3                                      ;
                                       52 D4 000E3 15$:  CLRL    R2                                      ;
                             08        50 D1 000E5       CMPL    MODE, #8                                ;
                                       02 12 000E8       BNEQ    16$                                     ;
                                       52 D6 000EA       INCL    R2                                      ;
                                       51 D4 000EC 16$:  CLRL    R1                                      ;
                             09        50 D1 000EE       CMPL    MODE, #9                                ;
                                       02 12 000F1       BNEQ    17$                                     ;
                                       51 D6 000F3       INCL    R1                                      ;
                             51        52 C8 000F5 17$:  BISL2   R2, R1                                  ;
                             55        53 D2 000F8       MCOML   R3, R5                                  ;
                             51        55 CA 000FB       BICL2   R5, R1                                  ;
                             01        51 D1 000FE       CMPL    R1, #1                                  ;
                                       41 12 00101       BNEQ    22$                                     ;
                       04    BC        01 D0 00103       MOVL    #1, @FLAG                               ; 0929
                             09        50 D1 00107       CMPL    MODE, #9                                ; 0930
                                       06 12 0010A       BNEQ    18$                                     ;
                       0C    BC        04 D0 0010C       MOVL    #4, @PTR_DISP_SIZE                      ; 0932
                                       0D 11 00110       BRB     19$                                     ;
                             7E   10   AC 7D 00112 18$:  MOVQ    INDEX, -(SP)                            ; 0935
                    D000V    CF        02 FB 00116       CALLS   #2, INS_CONTEXT                         ;
                       0C    BC        50 D0 0011B       MOVL    R0, @PTR_DISP_SIZE                      ;
                             50   0C   BC D0 0011F 19$:  MOVL    @PTR_DISP_SIZE, R0                      ; 0936
                             04        50 D1 00123       CMPL    R0, #4                                  ;
                                       03 15 00126       BLEQ    20$                                     ;
                             50        04 D0 00128       MOVL    #4, R0                                  ;
                             50        08 C4 0012B 20$:  MULL2   #8, R0                                  ;
  08  BC        6B           50        00 EF 0012E       EXTZV   #0, R0, (STREAM_PTR), @DISPL            ;
                             04   0C   BC D1 00134       CMPL    @PTR_DISP_SIZE, #4                      ; 0937
                                       04 15 00138       BLEQ    21$                                     ;
                             50        04 D0 0013A       MOVL    #4, R0                                  ; 0939
                                          04 0013D       RET                                             ;
                             5B   0C   BC C0 0013E 21$:  ADDL2   @PTR_DISP_SIZE, STREAM_PTR              ; 0940
                                       09 11 00142       BRB     23$                                     ; 0941
                                  04   BC D4 00144 22$:  CLRL    @FLAG                                   ; 0945
```

```
                                   0C    BC  D4 00147          CLRL    @PTR_DISP_SIZE                                          ; 0946
                                   08    BC  D4 0014A          CLRL    @DISPL                                                  ; 0947
                          50             01  D0 0014D 23$:     MOVL    #1, R0                                                  ; 0950
                                             04 00150          RET                                                             ; 0954

; Routine Size:  337 bytes,    Routine Base:  Z$DEBUG_CODE + 0326
```

```
1 %SBTTL 'INS_CONTEXT - Determine operand type'
1 ROUTINE ins_context (index, opcode) =
1
1 !---
1 !
1 !       This routine decides what context applies to the given
1 !       operand for a specific opcode.  It is used because we need
1 !       to know whether a pc-relative mode for this operand would
1 !       require a byte, word, longword, or quadword operand.
1 !
1 ! Inputs:
1 !
1 !       index = Which operand we're dealing with.  This number
1 !               must be 1, 2, ... 6.
1 !       opcode = The opcode we are currently working on.
1 !               (This parameter has already been validated.)
1 !
1 ! Routine value:
1 !
1 !       If some error is detected, we return false.  Otherwise we return
1 !       the number of bytes from the instruction stream that the current
1 !       operand reference should consume.
1 !
1 !   The value, 0 to 3, stored in the op_context field is simply
1 !   our encoding of 4 values into a 2-bit field.  The 'number of
1 !   bytes' entry, above, is the number we are actually after.
1 !--
1
2 BEGIN
2
2 !
2 ! check for any of the following error conditions:
2 !       1) we don't recognize this opcode.
2 !       2) we don't have enough information about it.
2 !          (ie - it is reserved or yet to be defined).
2 !       3) we know about it, but don't believe that it
2 !          should have as many operands as what
2 !          'index' implies.  this check is necessary
2 !          because the 'nul' entry in the opinfo
2 !          declaration macros results in the same value
2 !          being encoded as the 'byt' ones do.  since
2 !          we can cross-check for this error at this
2 !          point (by looking at the op_numops entry for
2 !          this opcode), it did not seem worth taking up more
2 !          bits in the opinfo table to differentiate 'nul'
2 !          and the others.
2 !
2
2 IF .lib$gb_opinfo [.opcode, op_numops] EQL not_an_op
2 THEN
2     RETURN 0;                               ! Error 2, see above.
2
2 IF .lib$gb_opinfo [.opcode, op_numops] LSS .index OR .index LEQ 0
2 THEN
2     RETURN 0;                               ! Error 3, see above.
2
2 ! now it is just a matter of looking into our opinfo table
2 ! where we get 0, 1, 2, or 3.  this just happens to be
```

```
;  778          1012  2 ! the power of 2 which we need to calculate the number
:  779          1013  2 ! of bytes occupied by the corresponding operand.
:  780          1014  2
:  781          1015  2 RETURN 1 ^ .lib$gb_opinfo [.opcode, op_context(.index)];
:  782          1016  2
;  783          1017  1 END;



                                                           003C 00000 INS_CONTEXT:
                                                                              .WORD     Save R2,R3,R4,R5                      : 0956
                                        55  00000000G    EF  9E 00002         MOVAB     LIB$GB_OPINFO1, R5                    :
                                        54  00000000G    EF  9E 00009         MOVAB     LIB$GB_OPINFO2, R4                    :
                                        50               04  D0 00010         MOVL      #4, OFFSET                            : 1002
                                        52         08    AC  D0 00013         MOVL      OPCODE, R2                            :
                                                         53  D4 00017         CLRL      R3                                    :
                                   FD   8F               52  91 00019         CMPB      R2, #253                              :
                                                         0C  13 0001D         BEQL      1$                                    :
                                                         53  D6 0001F         INCL      R3                                    :
                                        51             6042  7E 00021         MOVAQ     (OFFSET)[R2], R1                      :
                          50            51               55  C1 00025         ADDL3     R5, R1, R0                            :
                                                         0C  11 00029         BRB       2$                                    :
                          51            52         F8    8F  78 0002B 1$:     ASHL      #-8, R2, R1                           :
                                        50             6041  7E 00030         MOVAQ     (OFFSET)[R1], R0                      :
                                        50               54  C0 00034         ADDL2     R4, R0                                :
            0F            60            04               00  ED 00037 2$:     CMPZV     #0, #4, (R0), #15                     :
                                                         5D  13 0003C         BEQL      7$                                    :
                                        50               04  D0 0003E         MOVL      #4, OFFSET                            : 1006
                                        0A               53  E9 00041         BLBC      R3, 3$                                :
                                        51             6042  7E 00044         MOVAQ     (OFFSET)[R2], R1                      :
                          50            51               55  C1 00048         ADDL3     R5, R1, R0                            :
                                                         0C  11 0004C         BRB       4$                                    :
                          51            52         F8    8F  78 0004E 3$:     ASHL      #-8, R2, R1                           :
                                        50             6041  7E 00053         MOVAQ     (OFFSET)[R1], R0                      :
                                        50               54  C0 00057         ADDL2     R4, R0                                :
      04    AC            60            04               00  ED 0005A 4$:     CMPZV     #0, #4, (R0), INDEX                   :
                                                         39  19 00060         BLSS      7$                                    :
                                                   04    AC  D5 00062         TSTL      INDEX                                 :
                                                         34  15 00065         BLEQ      7$                                    :
                          50       04   AC               02  C7 00067         DIVL3     #2, INDEX, R0                         : 1015
                                        50               04  C0 0006C         ADDL2     #4, OFFSET                            :
                                        0A               53  E9 0006F         BLBC      R3, 5$                                :
                                        51             6042  7E 00072         MOVAQ     (OFFSET)[R2], R1                      :
                          50            51               55  C1 00076         ADDL3     R5, R1, R0                            :
                                                         0C  11 0007A         BRB       6$                                    :
                          51            52         F8    8F  78 0007C 5$:     ASHL      #-8, R2, R1                           :
                                        50             6041  7E 00081         MOVAQ     (OFFSET)[R1], R0                      :
                                        50               54  C0 00085         ADDL2     R4, R0                                :
            51       04   AC            01               00  EF 00088 6$:     EXTZV     #0, #1, INDEX, R1                     :
                                        51               04  C4 0008E         MULL2     #4, R1                                :
            52            60            03               51  EF 00091         EXTZV     R1, #3, (R0), R2                      :
                          50            01               52  78 00096         ASHL      R2, #1, R0                            :
                                                             04 0009A         RET                                             :
                                                         50  D4 0009B 7$:     CLRL      R0                                    : 1017
                                                             04 0009D         RET                                             :
```

```
; Routine Size:  158 bytes,    Routine Base:  Z$DEBUG_CODE + 0477
```

```
1 %SBTTL 'PUT_REG - Print a register name'
1 ROUTINE put_reg (reg, cs_flag): NOVALUE =
1
1 !---
1 !      This routine takes 1 parameter which it assumes is
1 !      the number of a vax register.  It then prints out
1 !      'r' followed by the number (in decimal), unless the
1 !      register number is 'special'.  These include:
1 !
1 !      Register number          Special name
1 !
1 !              12                  AP
1 !              13                  FP
1 !              14                  SP
1 !              15                  PC
1 !
1 !      An additional parameter is used as a flag to indicate
1 !      whether the register reference should be enclosed in
1 !      round/square brackets or not.
1 !
1 ! Inputs:
1 !
1 !      reg = The register number.
1 !      cs_flag = A flag to control printing before/after REG.
1 !
1 ! Outputs:
1 !
1 !      None.
1 !--
1
2 BEGIN
2
2 LOCAL
2     index;
2
2 BIND
2     enclosing_cs = UPLIT BYTE('(',')','[',']'): VECTOR [,BYTE],
2     regnames = UPLIT WORD('AP', 'FP', 'SP', 'PC'): VECTOR [,WORD];
2
2 !
2 ! If we are to put out any enclosing strings,
2 ! then we have been passed the INDEX which we
2 ! need to pick this string out of the above
2 ! vector.
2 !
2
2 index = .cs_flag;
2
2 IF .index NEQ no_brackets
2 THEN
2     append_string(1, enclosing_cs [.index]);
2
2 ! Now print the actual register reference.
2
2 IF .reg LSS ap_reg
2 THEN
3     BEGIN
```

```
:  842        1075  3         append('R');
:  843        1076  3         append_decimal(.reg);
:  844        1077  3         END
:  845        1078  2     ELSE
:  846        1079  2         append_string(2, regnames[.reg-12]);
:  847        1080  2
:  848        1081  2     ! See again if there is any enclosing string.
:  849        1082  2
:  850        1083  2     IF .index NEQ no_brackets
:  851        1084  2     THEN
:  852        1085  2         append_string(1, enclosing_cs [.index+1]);
:  853        1086  2
:  854        1087  1     END;



                                        28  00515 P.AAH:   .ASCII   \(\                                      :
                                        29  00516          .ASCII   \)\                                      :
                                        5B  00517          .ASCII   \[\                                      :
                                        5D  00518          .ASCII   \]\                                      :
                                            00519          .BLKB    1                                        :
                                    50  41  0051A P.AAI:   .ASCII   \AP\                                     :
                                    50  46  0051C          .ASCII   \FP\                                     :
                                    50  53  0051E          .ASCII   \SP\                                     :
                                    43  50  00520          .ASCII   \PC\                                     :
                                        52  00522 P.AAJ:   .ASCII   \R\                                      :

                                              ENCLOSING_CS=        P.AAH
                                              REGNAMES=            P.AAI


                                     0FFC  00000 PUT_REG:.WORD     Save R2,R3,R4,R5,R6,R7,R8,R9,R10,R11     :  1019
                      54     0000V   CF  9E  00002         MOVAB    APPEND_STRING, R4                        :
                      52        08   AC  D0  00007         MOVL     CS_FLAG, INDEX                           :  1064
                                     53  D4  0000B         CLRL     R3                                       :  1066
                      01             52  D1  0000D         CMPL     INDEX, #1                                :
                                     0C  13  00010         BEQL     1$                                       :
                                     53  D6  00012         INCL     R3                                       :
                      51     DA AF42     9E  00014         MOVAB    ENCLOSING_CS[INDEX], R1                  :  1068
                      50             01  D0  00019         MOVL     #1, R0                                   :
                                     64  16  0001C         JSB      APPEND_STRING                            :
                      0C        04   AC  D1  0001E 1$:     CMPL     REG, #12                                 :  1072
                                     13  18  00022         BGEQ     2$                                       :
                      51        D8   AF  9E  00024         MOVAB    P.AAJ, R1                                :  1075
                      50             01  D0  00028         MOVL     #1, R0                                   :
                                     64  16  0002B         JSB      APPEND_STRING                            :
                                04   AC  DD  0002D         PUSHL    REG                                      :  1076
               0000V  CF             01  FB  00030         CALLS    #1, APPEND_DECIMAL                       :
                                     0E  11  00035         BRB      3$                                       :  1072
                      50        04   AC  D0  00037 2$:     MOVL     REG, R0                                  :  1079
                      51     A0 AF40     3E  0003B         MOVAW    REGNAMES-24[R0], R1                      :
                      50             02  D0  00040         MOVL     #2, R0                                   :
                                     64  16  00043         JSB      APPEND_STRING                            :
                      0A             53  E9  00045 3$:     BLBC     R3, 4$                                   :  1083
                      51     A7 AF42     9E  00048         MOVAB    ENCLOSING_CS+1[INDEX], R1                :  1085
                      50             01  D0  0004D         MOVL     #1, R0                                   :
                                     64  16  00050         JSB      APPEND_STRING                            :
```

```
                                                           04 00052 4$:      RET                                              ; 1087

; Routine Size:  83 bytes,    Routine Base:  Z$DEBUG_CODE + 0523
;  856        1088  1 %SBTTL 'APPEND_ADDRESS - Symbolize value and append it'
;  857        1089  1 ROUTINE append_address (value, absflag): NOVALUE =
;  858        1090  1
;  859        1091  1 !---
;  860        1092  1 !
;  861        1093  1 !       This routine converts a given absolute value to a symbol
;  862        1094  1 !       and an offset (if possible) and appends the resulting string
;  863        1095  1 !       to the current output buffer.
;  864        1096  1 !
;  865        1097  1 ! Inputs:
;  866        1098  1 !
;  867        1099  1 !       value = Absolute value to be converted
;  868        1100  1 !       absflag = True if absolute address, else relative address
;  869        1101  1 !
;  870        1102  1 ! Outputs:
;  871        1103  1 !
;  872        1104  1 !       Either the hex value or the symbol+offset is appended.
;  873        1105  1 !---
;  874        1106  1
;  875        1107  2 BEGIN
;  876        1108  2
;  877        1109  2 IF .user_symbolize_routine EQL 0
;  878        1110  2 THEN
;  879        1111  2     append_hex(.value,4)
;  880        1112  2 ELSE
;  881        1113  3     BEGIN
;  882        1114  3     LOCAL
;  883        1115  3         retlen: WORD,
;  884        1116  3         buffer_left: VECTOR [2];
;  885        1117  3     buffer_left [0] = .user_buffer_left;
;  886        1118  3     buffer_left [1] = .user_buffer_address;
;  887        1119  3     IF (.user_symbolize_routine)(value,buffer_left,retlen,absflag)
;  888        1120  3     THEN
;  889        1121  4         BEGIN
;  890        1122  4         user_buffer_address = .user_buffer_address + .retlen;
;  891        1123  4         user_buffer_left = .user_buffer_left - .retlen;
;  892        1124  4         END
;  893        1125  3     ELSE
;  894        1126  3         append_hex(.value,4);
;  895        1127  2     END;
;  896        1128  2
;  897        1129  1 END;



                                        000C 00000 APPEND_ADDRESS:
                                                         .WORD   Save R2,R3                                  ; 1089
                 53     FA8E   CF   9E 00002            MOVAB   USER_BUFFER_LEFT, R3                        ;
                 5E              0C   C2 00007            SUBL2   #12, SP                                     ;
                 52       F6   A3   D0 0000A            MOVL    USER_SYMBOLIZE_ROUTINE, R2                  ; 1109
                                 26   13 0000E            BEQL    1$                                          ;
       04        AE              63   3C 00010            MOVZWL  USER_BUFFER_LEFT, BUFFER_LEFT               ; 1117
       08        AE       FA   A3   D0 00014            MOVL    USER_BUFFER_ADDRESS, BUFFER_LEFT+4          ; 1118
                          08   AC   9F 00019            PUSHAB  ABSFLAG                                     ; 1119
                          04   AE   9F 0001C            PUSHAB  RETLEN                                      ;
```

```
                                  0C   AE   9F 0001F            PUSHAB  BUFFER_LEFT                      ;
                                  04   AC   9F 00022            PUSHAB  VALUE                            ;
                          62           04   FB 00025            CALLS   #4, (R2)                         ;
                          0B           50   E9 00028            BLBC    R0, 1$                           ;
                          50           6E   3C 0002B            MOVZWL  RETLEN, R0                       ; 1122
                   FA     A3           50   C0 0002E            ADDL2   R0, USER_BUFFER_ADDRESS          ;
                          63           6E   A2 00032            SUBW2   RETLEN, USER_BUFFER_LEFT         ; 1123
                                            04 00035            RET                                      ; 1119
                                       04   DD 00036 1$:        PUSHL   #4                               ; 1126
                                  04   AC   DD 00038            PUSHL   VALUE                            ;
               0000V      CF           02   FB 0003B            CALLS   #2, APPEND_HEX                   ;
                                            04 00040            RET                                      ; 1129

; Routine Size:  65 bytes,    Routine Base:  Z$DEBUG_CODE + 0576
;   899          1130  1 %SBTTL 'APPEND_HEX - Append variable size hex value'
;   900          1131  1 ROUTINE append_hex (value, bytes): NOVALUE =
;   901          1132  1
;   902          1133  1 !---
;   903          1134  1 !
;   904          1135  1 !        This routine appends a given hex value to the current output
;   905          1136  1 !        buffer.
;   906          1137  1 !
;   907          1138  1 ! Inputs:
;   908          1139  1 !
;   909          1140  1 !        value = Absolute value
;   910          1141  1 !        bytes = Number of bytes to display
;   911          1142  1 !
;   912          1143  1 ! Outputs:
;   913          1144  1 !
;   914          1145  1 !        The hex value is appended.
;   915          1146  1 !---
;   916          1147  1
;   917          1148  2 BEGIN
;   918          1149  2
;   919          1150  2 LOCAL
;   920          1151  2     number;
;   921          1152  2
;   922          1153  2 BIND
;   923          1154  2     digit_table = UPLIT BYTE('0123456789ABCDEF'): VECTOR [,BYTE];
;   924          1155  2
;   925          1156  2 number = .value;
;   926          1157  2
;   927          1158  2 IF .number LSS 0                        ! If negative value,
;   928          1159  2 THEN
;   929          1160  3     BEGIN
;   930          1161  3     append('-');                        ! Output minus sign
;   931          1162  3     number = -.number;                  ! and print the absolute value
;   932          1163  2     END;
;   933          1164  2
;   934          1165  2 DECR i FROM .bytes*8-4 TO 0 BY 4       ! For each nibble,
;   935          1166  2 DO
;   936          1167  2     append_string(1, digit_table [.number <.i,4>]); ! Output the digit
;   937          1168  2
;   938          1169  1 END;


45 44 43 42 41 39 38 37 36 35 34 33 32 31  30  005B7 P.AAK:  .ASCII  \0123456789ABCDEF\                    ;
                                           46  005C6                                                      ;
                                           2D  005C7 P.AAL:  .ASCII  \-\                                  ;

                                                     DIGIT_TABLE=      P.AAK


                                        0FFC  00000 APPEND_HEX:
                                                             .WORD   Save R2,R3,R4,R5,R6,R7,R8,R9,R10,R11  ; 1131
                        53       04   AC  D0  00002          MOVL    VALUE, NUMBER                         ; 1156
                                      0D  18  00006          BGEQ    1$                                    ; 1158
                        51       F4   AF  9E  00008          MOVAB   P.AAL, R1                             ; 1161
                        50            01  D0  0000C          MOVL    #1, R0                                ;
                                   0000V  30  0000F          BSBW    APPEND_STRING                         ;
```

```
                                    53            53  CE 00012        MNEGL   NUMBER, NUMBER                                          ; 1162
                                    52      08    AC  D0 00015 1$:    MOVL    BYTES, R2                                               ; 1165
                                    52            08  C4 00019        MULL2   #8, R2                                                  ;
                                                  10  11 0001C        BRB     3$                                                      ;
       50            53             04            52  EF 0001E 2$:    EXTZV   I, #4, NUMBER, R0                                       ; 1167
                                    51      C8 AF40   9E 00023        MOVAB   DIGIT_TABLE[R0], R1                                     ;
                                    50            01  D0 00028        MOVL    #1, R0                                                  ;
                                               0000V  30 0002B        BSBW    APPEND_STRING                                           ;
                                    52            04  C2 0002E 3$:    SUBL2   #4, I                                                   ;
                                                  EB  18 00031        BGEQ    2$                                                      ;
                                                      04 00033        RET                                                             ; 1169

; Routine Size:  52 bytes,    Routine Base:  Z$DEBUG_CODE + 05C8
;  940          1170  1 %SBTTL 'APPEND_DECIMAL - Append unsigned decimal value'
;  941          1171  1 ROUTINE append_decimal (value): NOVALUE =
;  942          1172  1
;  943          1173  1 !---
;  944          1174  1 !
;  945          1175  1 !       This routine appends a given unsigned decimal value
;  946          1176  1 !       to the current output buffer.
;  947          1177  1 !
;  948          1178  1 ! Inputs:
;  949          1179  1 !
;  950          1180  1 !       value = Number to be output
;  951          1181  1 !
;  952          1182  1 ! Outputs:
;  953          1183  1 !
;  954          1184  1 !       The decimal value is appended, without any padding or fill.
;  955          1185  1 !---
;  956          1186  1
;  957          1187  2 BEGIN
;  958          1188  2
;  959          1189  2 LINKAGE
;  960          1190  2     recursive_jsb = JSB: GLOBAL(number=2);
;  961          1191  2
;  962          1192  2 GLOBAL REGISTER
;  963          1193  2     number = 2;
;  964          1194  2
;  965          1195  2 ROUTINE output_remaining_digits: recursive_jsb NOVALUE =
;  966          1196  3     BEGIN
;  967          1197  3     EXTERNAL REGISTER number=2;
;  968          1198  3     LOCAL char: BYTE;
;  969          1199  3     char = '0' + (.number MOD 10);
;  970          1200  3     number = .number / 10;
;  971          1201  3     IF .number NEQ 0 THEN output_remaining_digits();
;  972          1202  3     append_string(1, char);
;  973          1203  2     END;



                                 5E          04  C2 00000 OUTPUT_REMAINING_DIGITS:
                                                                   SUBL2   #4, SP                                      ; 1195
          7E          00         52          01  7A 00003          EMUL    #1, NUMBER, #0, -(SP)                       ; 1199
          50          50         8E          0A  7B 00008          EDIV    #10, (SP)+, R0, R0                          ;
                      6E         50          30  81 0000D          ADDB3   #48, R0, CHAR                               ;
                                 52          0A  C6 00011          DIVL2   #10, NUMBER                                 ; 1200
                                             02  13 00014          BEQL    1$                                          ; 1201
                                             E8  10 00016          BSBB    OUTPUT_REMAINING_DIGITS                     ;
                                 51          6E  9E 00018 1$:      MOVAB   CHAR, R1                                    ; 1202
                                 50          01  D0 0001B          MOVL    #1, R0                                      ;
                                          0000V  30 0001E          BSBW    APPEND_STRING                               ;
                                 5E          04  C0 00021          ADDL2   #4, SP                                      ; 1203
                                                 05 00024          RSB                                                 ;

; Routine Size:  37 bytes,    Routine Base:  Z$DEBUG_CODE + 05FC


;  974          1204  2
;   975          1205  2 number = .value;
;   976          1206  2 output_remaining_digits();
;   977          1207  2
;   978          1208  1 END;




                                                    OFFC 00000 APPEND_DECIMAL:
                                                                      .WORD   Save R2,R3,R4,R5,R6,R7,R8,R9,R10,R11          ; 1171
                         52       04    AC  D0 00002                  MOVL    VALUE, NUMBER                                 ; 1205
                                        D3  10 00006                  BSBB    OUTPUT_REMAINING_DIGITS                       ; 1206
                                            04 00008                  RET                                                   ; 1208

; Routine Size:  9 bytes,    Routine Base:  Z$DEBUG_CODE + 0621
```

```
%SBTTL 'APPEND_RAD50 - Append RAD50 characters'
ROUTINE append_rad50 (nwords, words): NOVALUE =

!---
!
!       This routine converts a series of RAD50 words to ASCII and
!       appends it to the current output buffer.
!
! Inputs:
!
!       nwords = Number of words to convert
!       words = Address of words to convert
!
! Outputs:
!
!       The string is appended, without any padding or fill.
!---

BEGIN

MAP
    words:      REF VECTOR [,WORD];       ! Address of array of words

LOCAL
    number:     WORD,
    char:       VECTOR [3,BYTE];          ! 3 character array

INCRU word_number FROM 0 TO .nwords-1   ! For each word to convert,
DO
    BEGIN
    number = .words [.word_number];     ! Get value of word

    DECR i FROM 2 TO 0                  ! For 3 characters,
    DO
        BEGIN
        char [.i] = .number MOD 40;     ! Get low order character
        number = .number / 40;          ! and divide by 40
        END;

    INCR i FROM 0 TO 2                  ! For each of the 3 characters,
    DO
        BEGIN
        SELECTONEU .char [.i]
        OF
            SET
            [0]:          char [.i] = ' ';
            [1 TO 26]:    char [.i] = .char [.i] + 'A' - 1;
            [27]:         char [.i] = '$';
            [OTHERWISE]: char [.i] = .char [.i] + '.' - 28;
            TES;
        append_string(1, char [.i]);
        END;
    END;

END;
```

```
                                              OFFC 00000 APPEND_RAD50:
                                                                  .WORD    Save R2,R3,R4,R5,R6,R7,R8,R9,R10,R11        ; 1210
                 55        04    AC        01   C3 00002          SUBL3    #1, NWORDS, R5                              ; 1236
                                           53   D4 00007          CLRL     WORD_NUMBER                                 ; 1239
                                           58   10 00009          BSBB     8$                                          ;
                                 54   08 BC43   B0 0000B 1$:      MOVW     @WORDS[WORD_NUMBER], NUMBER                 ;
                                 50        02   D0 00010          MOVL     #2, I                                       ; 1241
                                 51        54   3C 00013 2$:      MOVZWL   NUMBER, R1                                  ; 1244
      7E         00              51        01   7A 00016          EMUL     #1, R1, #0, -(SP)                           ;
      51         51              8E        28   7B 0001B          EDIV     #40, (SP)+, R1, R1                          ;
                               6E40        51   90 00020          MOVB     R1, CHAR[I]                                 ;
                                 51        54   3C 00024          MOVZWL   NUMBER, R1                                  ; 1245
                                 51        28   C6 00027          DIVL2    #40, R1                                     ;
                                 54        51   B0 0002A          MOVW     R1, NUMBER                                  ;
                                 E3        50   F4 0002D          SOBGEQ   I, 2$                                       ; 1241
                                           52   D4 00030          CLRL     I                                           ; 1248
                 51              52        5E   C1 00032 3$:      ADDL3    SP, I, R1                                   ; 1251
                                           61   95 00036          TSTB     (R1)                                        ; 1254
                                           05   12 00038          BNEQ     4$                                          ;
                                 61        20   90 0003A          MOVB     #32, (R1)                                   ;
                                           18   11 0003D          BRB      7$                                          ;
                                 1A        61   91 0003F 4$:      CMPB     (R1), #26                                   ; 1255
                                           06   1A 00042          BGTRU    5$                                          ;
                                 61    40  8F   80 00044          ADDB2    #64, (R1)                                   ;
                                           0D   11 00048          BRB      7$                                          ;
                                 1B        61   91 0004A 5$:      CMPB     (R1), #27                                   ; 1256
                                           05   12 0004D          BNEQ     6$                                          ;
                                 61        24   90 0004F          MOVB     #36, (R1)                                   ;
                                           03   11 00C52          BRB      7$                                          ;
                                 61        12   80 00054 6$:      ADDB2    #18, (R1)                                   ; 1257
                                 50        01   D0 00057 7$:      MOVL     #1, R0                                      ; 1259
                                        0000V   30 0005A          BSBW     APPEND_STRING                               ;
                 D1              52        02   F3 0005D          AOBLEQ   #2, I, 3$                                   ; 1248
                                           53   D6 00061          INCL     WORD_NUMBER                                 ; 1236
                                 55        53   D1 00063 8$:      CMPL     WORD_NUMBER, R5                             ;
                                           A3   1B 00066          BLEQU    1$                                          ;
                                                04 00068          RET                                                  ; 1263

; Routine Size:  105 bytes,    Routine Base:  Z$DEBUG_CODE + 062A
; 1036          1264  1 %SBTTL 'APPEND_STRING - Append to output buffer'
; 1037          1265  1 ROUTINE append_string (length, string): append_linkage NOVALUE =
; 1038          1266  1
; 1039          1267  1 !----
; 1040          1268  1 !
; 1041          1269  1 !       Append a string to the current output buffer.
; 1042          1270  1 !
; 1043          1271  1 ! Inputs:
; 1044          1272  1 !
; 1045          1273  1 !       length = Length of string
; 1046          1274  1 !       string = Address of string
; 1047          1275  1 !
; 1048          1276  1 !       user_buffer_address = Address of next available byte in user buffer
; 1049          1277  1 !       user_buffer_left = Number of bytes left in user buffer
; 1050          1278  1 !
; 1051          1279  1 ! Outputs:
; 1052          1280  1 !
; 1053          1281  1 !       user_buffer_address, user_buffer_left are updated.
; 1054          1282  1 !----
; 1055          1283  1
; 1056          1284  2 BEGIN
; 1057          1285  2
; 1058          1286  2 IF .user_buffer_left GEQ .length        ! If enough room left,
; 1059          1287  2 THEN
; 1060          1288  3     BEGIN
; 1061          1289  3     CH$MOVE(.length, .string, .user_buffer_address);
; 1062          1290  3     user_buffer_address = .user_buffer_address + .length;
; 1063          1291  3     user_buffer_left = .user_buffer_left - .length;
; 1064          1292  2     END;
; 1065          1293  2
; 1066          1294  1 END;



                                              007C   8F  BB 00000 APPEND_STRING:
                                                                           PUSHR  #^M<R2,R3,R4,R5,R6>                        ; 1265
                                       56            50  D0 00004          MOVL   R0, R6                                      ;
           56    F96A    CF            10            00  ED 00007          CMPZV  #0, #16, USER_BUFFER_LEFT, LENGTH           ; 1286
                                                     10  19 0000E          BLSS   1$                                          ;
                 F95B    DF            61            56  28 00010          MOVC3  LENGTH, (STRING), @USER_BUFFER_ADDRESS      ; 1289
                                F956   CF            56  C0 00016          ADDL2  LENGTH, USER_BUFFER_ADDRESS                 ; 1290
                                F957   CF            56  A2 0001B          SUBW2  LENGTH, USER_BUFFER_LEFT                    ; 1291
                                              007C   8F  BA 00020 1$:      POPR   #^M<R2,R3,R4,R5,R6>                        ; 1294
                                                         05 00024          RSB                                                ;

; Routine Size:  37 bytes,    Routine Base:  Z$DEBUG_CODE + 0693
; 1068          1295  1 END
; 1069          1296  0 ELUDOM



;                                       PSECT SUMMARY
;
;       Name                        Bytes                       Attributes
;
;  Z$DEBUG_CODE                         1720  NOVEC,  WRT,  RD ,  EXE,NOSHR,  LCL,  REL,  CON,  PIC,ALIGN(2)



;                               Library Statistics
;
;                                              -------- Symbols --------          Pages         Processing
;       File                                   Total    Loaded   Percent          Mapped        Time
;
;  _$255$DUA28:[SYSLIB]STARLET.L32;1            9776         3         0           581            00:00.8



;                                       COMMAND QUALIFIERS

;       BLISS/CHECK=(FIELD,INITIAL,OPTIMIZE)/LIS=LIS$:DECODE/OBJ=OBJ$:DECODE MSRC$:DECODE/UPDATE=(ENH$:DECODE)

; Size:           1655 code + 65 data bytes
; Run Time:          00:20.7
; Elapsed Time:      01:32.4
; Lines/CPU Min:      3754
; Lexemes/CPU-Min: 23351
; Memory Used:  165 pages
; Compilation Complete
```

0351 AH-BT13A-SE
VAX/VMS V4.0

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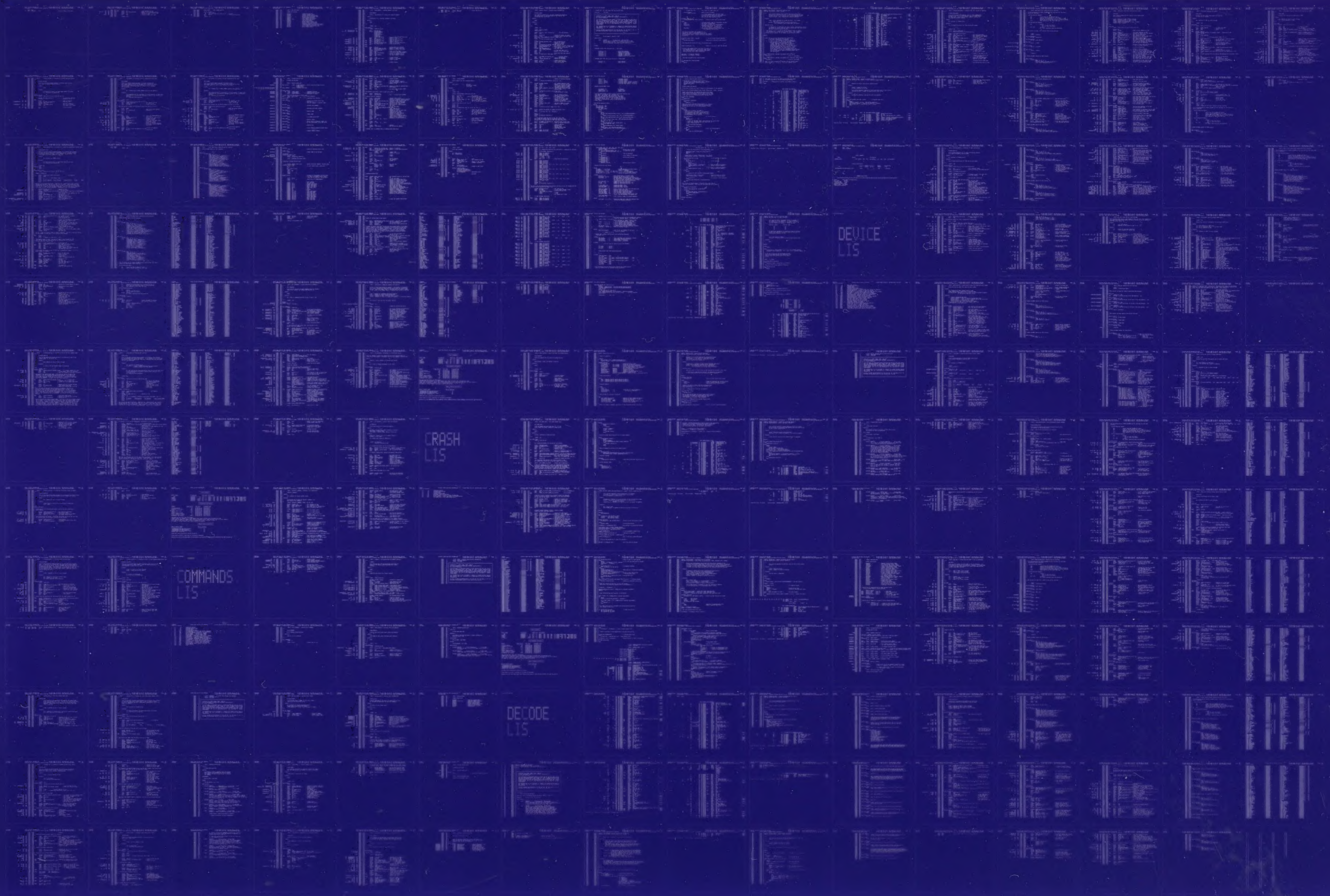

DEVICE
LIS

CRASH
LIS

COMMANDS
LIS

DECODE
LIS